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The Sixty-Seventh Meeting of the American Astronomical Society

By CURVIN H. GINGRICH

The Council of the American Astronomical Society having accepted the invitation given by Dr. J. J. Nassau, Director of the Warner and Swasey Observatory of the Case School of Applied Science, to hold the winter meeting in Cleveland under the aegis of the Warner and Swasey Observatory, the usual number of members of the Society started journeying toward that city on Saturday and Sunday, December 27, 28. Usually the announcement of the meeting includes a list of suggestions as to how to reach the place of meeting. This time the secretary condensed this body of information into the two pithy sentences which follow: "It is assumed that members will be able to figure out how to get to Cleveland, hence there is no paragraph on transportation. Several railroads go there." Thus the members were left to their own devices. However, upon arriving at the expansive Union Terminal or at one of the other depots in Cleveland, they were fully convinced of the truth of the second of the sentences quoted!

The Wade Park Manor, a hotel of the residential type, was selected as headquarters. This hotel is located in the section known as University Circle, and is near the campus of the Case School of Applied Science which is adjacent to the campus of Western Reserve University. The ball room of the hotel was available and entirely suitable for the several sessions, hence nothing was lacking in convenience and comfort for the successful conduct of the meeting.

The program called for a meeting of the Council on Sunday afternoon and for a Conference of Teachers of Astronomy in the evening. Those who arrived early in the afternoon and who were not obligated to be present at the meeting of the Council were able to avail themselves of the opportunity of a visit to the New Burrell Observatory at Baldwin-Wallace College at Berea, about thirteen miles from the center of Cleveland. This visit was made possible through an invitation from Dr. O. L. Dustheimer, Director of the Burrell Observatory. Moreover, promptly at 2:00 P.M., as announced, the Baldwin-Wallace College bus was at the door of the Manor to furnish transportation to Berea. This part of the arrangements was under the direction of Dr. Paul R. Annear, a member of the staff of the Burrell Observatory. Dr. Annear selected a route which enabled the guests to see the center of the city, the recently completed lake shore drive in the west end of the city, and

the large airport a few miles away. The sky was extremely cloudy and visibility very poor, but those who were not already familiar with Cleveland and its environs were very glad to have the benefit of this personally conducted tour. Upon arrival at the Observatory, the party was met by Dr. Dustheimer who in his usual genial manner exhibited the many interesting features built into his new observatory. The principal instrument, a refracting telescope, is ready for use except for the lens which is nearing completion at the Warner and Swasey Company shops. The finishing of the lens has been delayed because of priority given to defense materials which this firm is producing in large quantities. After an hour of inspection the visitors extended congratulations to Dr. Dustheimer and his staff upon the completion of so modern and so beautiful an observatory. The party was then returned to Cleveland and the Manor, feeling that the afternoon had been pleasantly and profitably spent.

By eight o'clock on Sunday evening, nearly one hundred members had arrived. At that hour they assembled in the ball room for the Conference of Teachers of Astronomy. The conference was under the direction of a committee of which Dr. John H. Pitman of the Sproul Observatory is chairman. Dr. Pitman introduced Dr. Frederick Slocum, Director of the Van Vleck Observatory of Wesleyan University, Middletown, Connecticut, who presented a paper on the topic "Stellar Distances." Because of Dr. Slocum's long and successful labors in this field, he was especially well fitted to bring out its salient features. Moreover, his extended experience as a college teacher enabled him to present the material clearly and comprehensively. The complete text of this paper will be published in the following issue of this magazine.

After the paper by Dr. Slocum, Dr. Pitman called upon Dr. S. G. Barton of the Flower Observatory, chairman of a committee on nomenlature, for a report. This committee after much study and investigation has come to definite conclusions in regard to the spelling and the pronunciation of the names of the constellations and of the principal stars. The publishing of this list will probably soon be authorized, and the list will then serve to decide many questions about which there is much difference of opinion.

Promptly at nine-thirty o'clock on Monday morning, the first session for papers was called to order by the president, Dr. Joel Stebbins, Director of the Washburn Observatory of the University of Wisconsin. Dr. William E. Wickenden, President of Case School of Applied Science, was introduced. He warmly welcomed the members of the Society and expressed his pleasure at having them present at this time to participate in the ceremonies attendant upon the completion of certain important additions to the Warner and Swasey Observatory of the Case School. In a few well-chosen words Dr. Stebbins referred to the general mental and emotional unrest occasioned by world conditions. He said that, even though for these two days we should be somewhat

secluded and seemingly isolated from the urgent war activities, we need not necessarily feel that we are recreant to duty, because scientific investigations must be continued even in war since science can contribute greatly to the successful prosecution of the war. This point of view was further emphasized by a quotation from a paper by the late Dr. George E. Hale, written during the World War I in 1917, printed on the program issued by the secretary, Dr. Dean B. McLaughlin. The quotation follows:

> "There remain to be considered the great majority of astronomers, whose duty and privilege it will be to carry forward their investigations during the period of the war. Recent events . . . have emphasized in the strongest manner the dignity and importance of scientific research. The tendency shown by some critics of limited view to measure the importance of research in terms of its immediate applicability to practical affairs is not justified by the facts. On the contrary, it is certainly fair to say that no science has done more for the world than astronomy. This is not chiefly because of its determination of the time, or the system of navigation it has developed, fundamentally important though these be. It is rather because of the sweeping change in human thought that astronomy has wrought and is still effecting, and the stimulating influence of the oldest of the sciences upon other sciences of later development. But I need not dwell on a theme which has been so luminously developed by Poincaré in "La Valeur de la Science." In his demonstration of the importance of astronomy to the world we find ample justification for the work we are doing, and the strongest encouragement to continue its pursuit in the interest of national progress."

However, the war was not thereby entirely banished from our thoughts. The newspapers were eagerly scanned and radio reports were earnestly sought in order to learn the latest developments in Europe, Africa, or the Far East. Moreover, Major O. E. Henderson and an assistant officer came by plane from Washington to bring to the attention of the astronomers the opportunities in the air service for young men with proper qualifications. With the constantly accelerating number of aeroplanes being made ready for use there is increasing need for trained pilots, navigators, and bombardiers. The astronomers were requested to direct the attention of young men to this branch of service, which they readily agreed to do. The presence of Colonel Philip Fox in his military uniform still further kept the thought of the war before us. In normal times Colonel Fox would have been present as Professor Fox in civilian dress and taking an active part in the astronomical matters under discussion. On this occasion through his conversations and through his stirring after-dinner address, he profoundly impressed the gathering with the critical situation in which events had placed this country and the consequent necessity for each person to give the utmost of his ability to the cause.

A second session for papers was held on Monday afternoon and a third on Tuesday afternoon, all in the ball room of the Wade Park Manor. Some thirty papers covering a wide range of topics were presented at these three sessions. No attempt will be made here to summarize the contents of these varied papers. They will be published in

abstract in the *Publications of the American Astronomical Society* and will thus become available to all members and to any others who may wish to secure them.

The event of Monday evening was awaited with unusual interest. The program scheduled a public lecture by Dr. Harlow Shapley on the subject "Galactic Explorations with the Newer Telescopes," for that evening. It seems that Dr. Shapley had lectured in Cleveland on previous occasions and consequently it was necessary to use Severance Hall, with a seating capacity of 1800, for this lecture. Those who came last found difficulty in getting into the hall, because large numbers of Cleveland citizens were in attendance. In addition to the attraction furnished by a lecture by Dr. Shapley, the people of Cleveland had a second interest in the exercises of the evening. The session was presided over by President Wickenden. He introduced Frank L. Quail, LL.D., president of the Board of Trustees of Case School. Dr. Quail read a brief paper in the form of a dedicatory address for the new Burrell telescope recently installed at the Warner and Swasey Observatory. The Warner and Swasey Observatory, as its name implies, having been built by the founders of the Cleveland firm, well and favorably known throughout the world for its instruments of precision, the new Burrell telescope having been given by Mrs. Katherine Burrell in memory of her husband, Edward Parker Burrell, who was for many years Director of Engineering at the Warner and Swasey Company, this entire astronomical institution is seen to be a Cleveland project in inception and execution from beginning to end. It is of such high quality that all Cleveland citizens may justly take pride in it. This then was their second interest in the occasion.

President Wickenden then extended his personal felicitations and those of the people of Cleveland to Dr. J. J. Nassau for his efficient and untiring efforts in bringing the Warner and Swasey Observatory and its equipment to the present degree of perfection. He then introduced Dr. Joel Stebbins who in turn introduced Dr. Harlow Shapley. The astronomical lecture was generously illustrated with photographs of the heavens made with instruments of which the new telescope just dedicated is typical. Dr. Shapley's comments concerning the photographs could confidently be accepted as representing the present state of knowledge of the universe for the audience had the rare privilege of listening to a master in the subject he was treating.

At the close of the lecture, busses provided by the Case School were in readiness to transport the members of the Society and their friends to the Warner and Swasey Observatory some four miles away. Upon arriving at the Observatory, the astronomers were immediately delighted by the appointments of the building, the handsomely furnished offices and work rooms, the ingeniously and attractively designed models of various kinds, and the beautiful new mounting of the Schmidt-type Burrell telescope. In the course of time it became known that refresh-

ments were being served in the Warner Memorial Auditorium, a part of the Observatory. This auditorium is furnished with a spacious lecture table and seating for 128 persons, each seat being equipped with a convenient arm for use in taking notes. For the evening these features were used for quite a different purpose. The lecture table became an attractive serving table containing delicacies too tasty to be described and too varied to be listed. The seats with their note-taking arms served as individual tables in such close proximity to each other that the sociability of the occasion was thereby enhanced. Nothing could have been done to make the evening more enjoyable. At the close the busses again were waiting to transport the guests to the hotel. One detail to show how thoughtfully the plans had been laid might be mentioned. On the return the busses were routed through the Grounds of the General Electric Company, Nela Park, to give the passengers an opportunity of seeing the very elaborate Christmas lighting effects shown there.

On Tuesday morning transportation was provided again to the Observatory and back to the hotel. The session of the morning was held in the auditorium which was the scene of the generous smörgasbord the evening before. This session was devoted to a symposium on the Schmidt-type telescope and its work. Four papers constituted the program.

1. The 24-inch Schmidt-type Telescope of the Warner and Swasey Observatory, by Dr. J. J. Nassau. This telescope being the most recently constructed one of this size and type consequently embodies many new features and improvements. These were clearly illustrated and explained in this paper.

2. Modification of the Schmidt, by Dr. James G. Baker of Harvard College Observatory. This paper was read by Dr. Shapley who explained that, just after the paper was written by Dr. Baker, the events of December 7 transpired. Dr. Baker immediately volunteered his services to his country and hence was unable to be present.

3. Large Objective Gratings for Schmidt Cameras, by Dr. R. W. Wood of Johns Hopkins University. The clear presentation of the work done by the speaker in the designing and adapting gratings to the large telescopes fully justified in the minds of those present the descriptive title given to Dr. Wood in his recent biography as "the wizard of the laboratory."

4. Galactic Problems, by Dr. Bart J. Bok of Harvard College Observatory. In this scholarly paper Dr. Bok described the recent work done, and pointed out ways in which the work will be very greatly advanced through modern equipment such as is represented by the new Burrell telescope.

The content of these papers, like the others, will be given more fully in the *Publications* to be published later.

Before returning to the hotel the photograph of the group was taken with the Warner and Swasey Observatory as the background.

The Society dinner was the last event on the program, and took place at the Wade Park Manor at seven o'clock on Tuesday evening. The ball room which had served as a place for scientific discussions during two days was transformed into a banquet room for this evening. About ninety-five members and guests were present for the dinner, a number having found it necessary to depart for home earlier in the day. The usual satisfying menu for such occasions was enjoyed during which conversation on various topics was indulged in at the tables arranged for eight persons. Dr. Joel Stebbins with his customary good humor and happy manner presided over the occasion and introduced a number of after-dinner speakers. Mr. Warner Seely, Secretary of the Warner and Swasey Company, was the first to speak. He casually referred to the part his firm had played in the construction and mounting of telescopes in the past and intimated that the financial status of his company might not be a very enviable one, if it were entirely dependent upon profits made from this source. He was followed by Dr. Shapley, who, Dr. Stebbins said, had hinted that he had omitted many things from his lecture the day before. Dr. Stebbins gave him this opportunity to complete his lecture. Dr. Shapley, however, chose to talk along quite a different line. Without divulging any military secrets he brought forth evidence that astrology was a potent influence in some foreign countries in this war. He intimated, moreover, that this strange doctrine sometimes shows itself in unexpected places of authority in this country also. He requested Dr. Bok to make a statement relative to astronomical exchanges with the belligerent nations. Dr. Bok said that up to the present the committee had been quite successful in effecting an exchange of astronomical literature, but was doubtful about the future, now that the war had engulfed many new nations.

Dr. Stebbins then read a message of greeting and good cheer intended to be sent to the Russian Academy of Sciences for its encouragement. The plan was unanimously adopted, and the document was circulated for the signatures of those present.

Mr. David Dietz, Science Editor of *The Cleveland Press,* was next introduced. Mr. Dietz disclaimed technical preparation for discussing astronomical questions and restricted himself to the more general science. He, however, has a keen interest in astronomy as is evidenced by his support of the so-called "Star-parties" now a well-established summer feature in Cleveland.

In introducing Colonel Philip Fox, Dr. Stebbins referred to the fact that in 1917 he suddenly found himself to be the secretary of the American Astronomical Society, the office having been left vacant by the departure of Professor Philip Fox for service in World War I. Professor Fox saw service both in the Philippine Islands and in France. Because of his wide experience and because of his ability as a speaker,

Colonel Fox was heard most intently. His words carried unusual weight and authority.

Dr. Heber D. Curtis, Director of the Observatories of the University of Michigan, then presented a happily phrased resolution expressing the appreciation and gratitude of the members of the Society to the hosts of this meeting for the courtesies and generosities extended to them during the meeting. The resolution was enthusiastically adopted.

No business was transacted by the Society at this meeting, this being left for the summer meeting. The Council was not yet able to state where the summer meeting would be held.

The meeting was officially adjourned at ten o'clock.

Report of the Committee on the Teaching of Astronomy

By MARJORIE WILLIAMS

The Committee on Teaching was selected at the conference held on September 7, 1941,[1] "to continue the work and arrange for future meetings." It has continued to function through correspondence, and during the Cleveland meeting of the American Astronomical Society, December 28-30, 1941, held three committee meetings at which general policies were discussed. It was agreed that our ultimate aim is to "devise means for the encouragement of the teaching of astronomy in American Colleges and Universities, having in mind that its value lies, not only in its broad aspects of understanding the workings of the universe but also in its cultural aspects." Several specific methods of carrying out this aim were discussed, and will be reported on as they are put into practice.

Progress has been made along several lines which were suggested at the Yerkes meeting. The committee on pronunciation and spelling has practically completed its work, and the report will soon be published in POPULAR ASTRONOMY. Dr. Mohler of the McMath-Hulbert Observatory announced that negatives are available for nine or ten films and that funds are available for producing some master negatives. The list was made public at the meeting and has been mailed to many teachers. Persons desiring the use of these films are urged to indicate their preference to Dr. Pitman at once. The Eastman Kodak Company has secured at our request a set of 28 Kodachrome slides 2 x 2 showing instruments and buildings of 10 observatories. Those interested in securing sets of these at low cost are asked to communicate with Dr. Pitman as soon as possible.

A session for teachers was arranged by Dr. Nassau for Sunday evening. An address on "Stellar Distances" was delivered by Professor

[1] See POPULAR ASTRONOMY, December, 1941, p. 531.

Frederick Slocum. Dr. Pitman introduced the members of the committee on pronunciation, Dr. Barton, the Reverend Mr. McHugh, and Mr. Davis, each of whom gave a report on the work of preparing the list of constellation and star names. They explained their method of procedure and the general rules which they have followed. They have given not only the spelling and pronunciation, but the meanings and derivations. These reports brought forth much public and private discussion. It was generally felt that the committee had been composed of competent scholars whose work was carefully done, and that their report will be as authoritative a piece of work as could be obtained. An important question in all our minds was "What can teachers of astronomy do for national defense?" And so it was of especial interest to have, as the final feature of the Sunday night meeting, talks from two officers of the Army Air Corps, who told us of the need for young men between the ages of 20 and 27 who can be trained as navigators. Teachers of astronomy were asked to urge properly qualified students to join the Air Corps. The qualifications are an alert mind, mechanical aptitude, and adequate training in science. Older men, and those with physical handicaps might qualify as civilian instructors.

The Council of the American Astronomical Society invited the chairman of the committee on teaching and the chairman of the sub-committee on pronunciation to attend the Monday afternoon meeting of the Council to make a report on plans and progress. The Council was in sympathy with the general program of the committee, and voted to make the Teacher's Committee a committee of the American Astronomical Society, with the committee on pronunciation as a sub-committee. A committee of five members was appointed as the Committee on Teaching: John H. Pitman, chairman, C. C. Wylie, J. J. Nassau, Alice H. Farnsworth, Marjorie Williams. Dr. Smiley, a member of the Council, voluntarily withdrew from the Committee of six which had been selected at the Yerkes meeting. The Council approved the publication of the report of the Committee on Spelling and Pronunciation. Plans for the early publication were arranged by the committee in consultation with the editor of POPULAR ASTRONOMY.

The Committee on Teaching wishes to represent the Teachers of Astronomy, and, as stated in the previous report, will welcome suggestions of any kind.

SMITH COLLEGE OBSERVATORY, NORTHAMPTON, MASSACHUSETTS.
JANUARY 13, 1942.

The Dallas Meeting of the Section on Astronomy of the American Association for the Advancement of Science

By C. C. WYLIE*

The Section on Astronomy of the American Association for the Advancement of Science met at Southern Methodist University, December 30-31, 1941, as part of the Dallas meeting of the Association, with Professor J. D. Boon of the University as host. The meetings were held in Hyer Hall. Lecture rooms, lanterns, moving picture projectors, and tables and cases for exhibits had been arranged for in advance by the local committee consisting of J. D. Boon and C. C. Albritton of the University, and O. E. Monnig of Forth Worth. No last minute arrangements whatever were necessary, although we understood such were necessary at some of the fifty other groups of the Association meeting in Dallas.

Special features of the meeting were the illustrated lecture on planets by E. C. Slipher of the Lowell Observatory, the illustrated lecture on eclipses, with colored moving pictures of the expedition to Brazil in 1940, by Rev. Paul A. McNally of Georgetown College, and the Sigma Xi lecture on the Expanding Universe by Dr. E. P. Hubble of Mount Wilson Observatory, Chairman of the Section on Astronomy.

There were some comprehensive invited papers, each dealing with the present knowledge and problems in a field, rather than with a special research problem. Among these were: a paper on Nebular Research by Dr. Hubble, a paper on Photometry of the Night Sky by Dr. C. T. Elvey of McDonald Observatory, a paper on Time Determination and Time Keeping prepared by Paul Sollenberger of the U.S. Naval Observatory and presented by G. M. Clemens of the same institution, a paper on Stellar Photometry by L. V. Robinson of the University of Mississippi, and a paper on Solar-Terrestrial Relationships prepared by Dr. H. T. Stetson of the Massachusetts Institute of Technology and presented by Dr. E. J. Prouse of the University of Texas.

The shorter papers included the Interference Monochromator by Dr. Edison Pettit, the Classification of Variable Stars by Dr. A. H. Joy, the Spectra of Planetary Nebulae by Dr. Rudolph Minkowski, all of Mount Wilson Observatory and all papers presented by Dr. Hubble of that institution: also, a paper on Astronomers in the Defense Program by C. C. Wylie.

A symposium on the Problems of Teaching Astronomy included a

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paper by S. L. Boothroyd, presented by L. V. Robinson: papers by Robert L. Price and Dinsmore Alter, presented by E. J. Prouse; a paper by C. C. Wylie; a paper by J. R. Naiden, presented by O. E. Monnig. Major G. B. Dany, Director of Navigation Training at Kelly Field, Texas, told the members of the Section that the problem of obtaining properly qualified teachers and students in air navigation was serious, and asked that university men cooperate with the Army Air Corps toward a solution. He stated that universities and colleges could render a greater service by giving good fundamental training in certain fields of mathematics, physics, and astronomy, than in attempting to teach a practical course in navigation. Major Dany stated further that the expansion planned for the Air Corps made the problem acute at the present time.

The exhibits included photographs by O. E. Monnig, Frank M. Preucil, and C. C. Wylie, text and reference books from several publishers, and meteorites and tektites by O. E. Monnig. Professor J. D. Boon, the host, exhibited a large motor-driven model of the solar system and a large motor-driven celestial globe. This globe was in a darkened room, and the stars were of phosphorescent paint glowing under an almost invisible light. Professor Boon exhibited also a motor-driven model of the earth moving about the sun, a motor-driven model to illustrate the center of gravity of the earth-moon system, and a model of certain lunar craters. Mr. O. A. Schumann of Houston, Texas, exhibited demonstration equipment including a motor-driven model of the solar system.

On Tuesday noon most of the members of the Section had lunch together at a cafeteria about four blocks from the place of meeting. On Wednesday noon the Section Luncheon was held in Virginia Hall of Southern Methodist University.

War work and defense work interfered with the plans of a considerable number who would otherwise have attended the meetings. Some authors of papers were unable to present them personally, and Dr. Robert R. Math, of the McMath-Hulbert Observatory, was unable to deliver his address as retiring chairman, since he had to be in Washington, D. C., throughout the week. The attendance was about 75.

The next meeting of the Association and of the Section on Astronomy is to be held at Ann Arbor, Michigan, June 22-27, 1942, war conditions permitting. Dr. McMath plans to give his retiring address at that meeting. Following the Ann Arbor Meeting, the next meeting of the Association and of the Section on Astronomy is to be held in New York City from December 28, 1942, to January 2, 1943, war conditions permitting.

University of Iowa, January 8, 1942.

Marvelous Voyages — II

The Scientific Romances of Edgar Rice Burroughs

By LAURENCE J. LAFLEUR

Edgar Rice Burroughs has written two series of marvelous voyages: one, like the Jules Verne tale already discussed, concerns the center of the earth; the other consists of his famous series of Martian stories, together with a few concerning the other planets. Despite the number of books involved, we will have no difficulty at all in dealing with them in a single article, for Burroughs does not possess the scientific interest of Jules Verne and H. G. Wells, and he avoids problems more often than he attempts to solve them.

The Center of the Earth

In a book entitled "At the Earth's Core," Burroughs tells how two men, Perry and Innes, travel through the earth in an "iron mole." This consists of a flexible steel cylinder with a revolving drill in the head operated by an engine which generates more power per cubic inch than any other engine does to the cubic foot. The stone which is macerated by the drill is passed to the rear of the machine through hollow spaces between the inner and outer shells. The cylinder contains a driver's seat so slung that it always remains upright, the necessary instruments, fuel, and the apparatus for replenishing the air. The inventors' intention is merely to test the machine, but when they start vertically downward at the rate of seven miles an hour, they find that the steering gear will not work and that they seem doomed to destruction. The mole has enough oil fuel to descend six or seven hundred miles beneath the surface, but their system of air replenishment will give out at about five hundred miles. Fortunately for them, the earth turns out to be hollow, with a shell just five hundred miles thick, so that they arrive safely on the inner surface.

During their journey they find that the temperature rises, at first rapidly, then more gradually, reaching a maximum of 153° F. at 84 miles under the surface. After 100 miles the heat decreases until at 240 miles below the surface the thermometer registers ten below zero and they pass through a stratum impregnated with ammonia. At 245 miles they enter a region of ice, where the temperature rises to 32 degrees above zero. This is precisely at the mid-point of the crust, and from this point on the mole is traveling upwards: *i.e.*, against the pull of gravitation. They pass through precisely the same temperature gradients inside the ice stratum as they did outside, though in reverse order.

The structure of the earth is thus described by Perry: "The earth was once a nebulous mass. It cooled, and as it cooled it shrank. At length a thin crust of solid matter formed upon its outer surface—a

sort of shell; but within it was partially molten matter and highly expanded gases. As it continued to cool . . . centrifugal force hurled the particles of the nebulous center toward the crust as rapidly as they approached a solid state. . . Presently there was only a small superheated core of gaseous matter remaining within a huge vacant interior left by the contraction of the cooling gases. The equal attraction of the solid crust from all directions maintained this luminous core in the exact center of the hollow globe. What remains of it is in the sun . . . a relatively tiny thing at the exact center of the earth. Equally to every part of this inner world it diffuses its perpetual noonday light and torrid heat." "The force of gravity is less upon the surface of the inner world than upon that of the outer. . . The difference is due in some part to the counter-attraction of that portion of the earth's crust directly opposite the spot . . . at which one's calculations are being made." And again, "This inner world must have cooled sufficiently to support animal life long ages after life appeared upon the outer crust, but that the same agencies were at work here is evident from the similar forms of both animal and vegetable creation."

Thus the groundwork is laid for what degenerates into a pure adventure story in a world populated by various types of men and many varieties of extinct animals, including the dinosaurs, one of which rules the underworld, controlling and domesticating human beings through its power of hypnotism. The book concludes with Innes marrying the underworld girl who has been giving the story its romantic interest.

Few points worth attention occur in the rest of the book or in the other books of the series. They include, however, the following: First, since there is no means of marking time where it is always noon, there is no time, or at least no feeling for time. One sleeps for an hour, day, month or year; or remains under water for long periods. While one person believes that an interval is of several weeks, another considers it a few minutes. For a similar reason there is no north, east, south, or west; and each creature has a homing instinct that tells it infallibly the direction of its home.

Another point of interest is that there is no horizon at any time, the distant land becoming invisible due to the distance, but for no other reason. The geography of the interior is a negative impression of our own, land areas lying beneath our seas, seas under our continents. In later books Burroughs supplies an opening through the earth's crust at the pole, which enables communication with the surface by dirigible. And finally, there is a tiny moon that circles the central sun of the interior.

The Martian Series

The Martian series seems to have consisted originally of three books; "A Princess of Mars," "The Gods of Mars," and "The Warlords of Mars," which three form a coherent whole. The later books become more and more implausible, and are even in outright contradiction to

the political geography of the first three. To us who are interested in the scientific aspects of marvelous voyages, therefore, none of the later works deserve a minute's consideration. And even in the earlier ones the problem of traveling the 48 million miles between the earth and Mars is avoided by having the hero, John Carter, get to Mars by the simple device of wishing while in an abnormal condition.

Arrived on Mars, Carter finds himself lying on a bed of a yellowish, moss-like vegetation which covers most of Mars. He is in a deep, circular basin, along the outer verge of which he can see irregular low hills. The time is noon, and the direct heat of the sun is intense, yet no greater than would have been true under similar conditions on an Arizona desert. These are Carter's first impressions. His second comes when he tries to rise and finds that, due to the lesser gravitation and lower air pressure, the effort sufficient to cause him to rise on earth sends him three yards into the air on Mars. In this and in all matters requiring strength of muscle Carter has a great advantage over the inhabitants of Mars who have muscles proportioned to Martian standards.

The geography of Mars is quite simple. Once having many seas, these have disappeared, and the Martians pump water through canals from the polar regions. The water being scarce and precious, it is actually piped direct to the roots of the plants cultivated along the canals so that none should be wasted. The nights on Mars "are extremely cold, and as there is practically no twilight or dawn, the changes in temperature are sudden and most uncomfortable, as are the transitions from brilliant daylight to darkness. The nights are either brilliantly illumined or very dark, for if neither of the two moons of Mars happens to be in the sky almost total darkness results, since the lack of atmosphere, or, rather, the very thin atmosphere, fails to diffuse the starlight to any great extent; on the other hand, if both of the moons are in the heavens at night the surface of the ground is brightly illuminated.

"Both of Mars' moons are vastly nearer her than is our moon to Earth; the nearer moon being but about five thousand miles distant, while the further is but a little more than fourteen thousand miles away, as against the nearly one-quarter million miles which separate us from our moon. The nearer moon of Mars makes a complete revolution around the planet in a little over seven and one-half hours, so that she may be seen hurtling through the sky like some huge meteor two or three times each night, revealing all her phases during each transit of the heavens. The further moon revolves about Mars in somewhat over thirty and one-quarter hours, and with her sister satellite makes a nocturnal Martian scene one of splendid and weird grandeur."

Life on Mars is similar to but not identical with that on Earth. Food includes "large juicy steaks from the well fed domestic animals; . . luscious fruits and vegetables, but not a single article of food which was exactly similar to anything on Earth." The animals run to extra pairs of limbs, and include only one mammal, which is quite rare. There

is an enormous white ape, a large green man with four arms and tusks, and a red man visibly identical with human beings. In fact, the Martians have telescopes much superior to our own, and report that "nearly every planet and star having atmospheric conditions at all approaching those of Mars shows forms of animal life almost identical with the men of Mars and Earth." Carter loves, marries, and has a child by a member of this reddish race of men. Both red and green men go almost naked, save for a leather and metal harness. Both are oviparous, the eggs growing for a period of five Martian years before hatching to give birth to a small but otherwise completely formed and active youngster. Both varieties of man and many Martian animals have a well-developed telepathic sense.

For a civilization supposedly well in advance of our own, the red Martians have remarkably little new to offer to our knowledge of physics. Radium is widely used, for illumination, power, and exploding bullets. Light has been analyzed and found to contain "the seven colors of our earthly prism and two beautiful rays which, to me (John Carter), were new and nameless. I cannot describe them any more than you could describe red to a blind man. I only know that they were beautiful in the extreme." The ninth ray is used to produce the artificial atmosphere which has supported life on Mars since the natural atmosphere became too tenuous. "This ray is separated from the other rays of the sun by means of finely adjusted instruments. . . This product is then treated electrically, or rather certain proportions of refined electric vibrations are incorporated with it, and the result is then pumped to the five principal air centers of the planet where, as it is released, contact with the ether of space transforms it into atmosphere." The eighth ray is used to give buoyancy to Martian airplanes. "The Martians have discovered that it is an inherent property of all light no matter from what source it emanates. They have learned that it is the solar eighth ray which propels the light of the sun to the various planets, and that it is the individual eighth ray of each planet which 'reflects' or propels the light thus obtained out into space once more. The solar eighth ray would be absorbed by the surface of Mars, but the Martian eighth ray, which tends to propel light from Mars into space, is constantly streaming out from the planet constituting a force of repulsion of gravity which when confined is able to lift enormous weights from the surface of the ground."

The scene of the second book of the series is the south pole of Mars, and in it we find a description of sunset. "The sun was setting, a huge red orb. . . So rare is the atmosphere of Mars that it absorbs very little heat from the sun. During the daylight hours it is always extremely hot; at night it is intensely cold. Nor does the thin atmosphere refract the sun's rays or diffuse its light as upon Earth. There is no twilight on Mars. When the great orb of day disappears beneath the horizon the effect is precisely as that of the extinguishing of a single lamp within

a chamber. From brilliant light you are plunged without warning into utter darkness. Then the moons come; the mysterious, magic moons of Mars, hurtling like monster meteors across the face of the planet."

This book also advances a theory of the evolution of life on Mars. A "Tree of Life" flourished twenty-three million years ago, whose fruit, for countless ages, "underwent the gradual changes of evolution, passing by degrees from true plant life to a combination of plant and animal. In the first stages the fruit of the tree possessed only the power of independent muscular action, while the stem remained attached to the parent plant; later a brain developed in the fruit, so that hanging there by their long stems they thought and moved as individuals. . . The buds . . . resembled large nuts about a foot in diameter, divided by double partition walls into four sections. In one section grew the plant man, in another a sixteen-legged worm, in the third the progenitor of the white ape, and in the fourth the primeval black man." These four escaped, and by their interbreeding produced all the forms of animal life to be found on Mars.

At the southern pole there is a huge underground cavern lit by the phosphorescence of its rocky vault, and containing a sea and a nation of black men. These use submarines as well as planes for conveyance, and have elevators of a type common on Mars. "They are operated by means of enormous magnets which are suspended at the top of the shaft. By an electrical device the volume of magnetism generated is regulated and the speed of the car varied. In long stretches they move at a sickening speed, especially on the upward trip, since the small force of gravity inherent to Mars results in very little opposition to the powerful force above."

The third book adds little of interest, other than that a race of yellow men living at the north pole have erected a huge electro-magnet over the pole which attracts to destruction all foreign aircraft which venture near, and that they live in a vast hothouse, manufacturing their air and storing in large containers the rays of the sun they use for heat and power.

Such is the outline of Burroughs' stories. Can you see where and how they involve impossibilities?

NOTE: *Readers are invited to report such scientific inaccuracies, inconsistencies, and fallacies as they may detect. The author has submitted a large number of scientific objections, but these will be witheld until a later issue.* EDITOR.

Time Determination and Time Keeping*

By PAUL SOLLENBERGER

The accepted units of time measurement are based on the period of rotation of the earth. Unfortunately this rotation does not furnish an entirely ideal basis for time measurement. One difficulty involved is that of the adoption of a suitable reference point with respect to which the earth's rotation can be measured. If it were not for the precession a fixed equatorial star having no proper motion would be an ideal reference point. The interval between successive meridian transits of such a star would be a true sidereal day. The ordinary sidereal day is the interval between two successive meridian transits of the vernal equinox; its length is affected by the irregularities of motion of the equinox of short and long periods and also by the small progressive change in the rate of that motion. In order to avoid these variations and to provide a day of less variable length, mean solar time was devised. Since this time is measured with reference to the mean fictitious sun it can not be determined directly by the observation of any celestial object; it must rather be determined by the use of formulas which make it possible to convert apparent solar or sidereal time into mean solar time. The formulas now in use were derived by Simon Newcomb. They were designed so that mean solar time would be free not only from the periodic terms arising from the nutation but also from the effect of the progressive change in the motion of the equinox. The effect of the inclusion of this progressive or secular term will be eventually to separate the fictitious from the true sun, so that after a sufficiently great period of time mean solar noon will no longer occur near to apparent noon. The formulas are, of course, not perfect and they therefore can not be expected to establish perfectly uniform time.

There is another reason, however, which is more important than that just noted in preventing the mean solar day from being an invariable unit. That is the variation in the speed of rotation of the earth. The variation may be considered to be made up of two parts. The first part is the gradual slowing down in the rate of rotation due to friction, mainly tidal, and the second consists of irregular changes due to corresponding changes in the earth's moment of inertia. The combined effect of these variations may be measured by observations of the Sun, Mercury, Venus, and Jupiter's satellites. The irregular changes are also determined, and with greater accuracy, by observations of the Moon's longitude. All of these sources indicate, for example, that there was a sudden change in the length of the day about 1900 and again about 1918. These changes amounted to approximately a hundredth of

*Paper read at the meeting of Section D of the A.A.A.S. at Dallas, Texas, on December 30, 1941.

a second in the length of a day. The cumulative effect in the course of a year was 3 or 4 seconds. In order to measure the amount of the gradual slowing down it is necessary to consider observations over a period sufficiently long to eliminate to a considerable extent the effects of the irregular changes. Eclipse observations over a period of 2000 years indicate that the slowing down causes the length of the year, as measured in mean solar days, to decrease by only about one half-second in the course of a century. In the period between 1900 and 1940 it appears that the rate of rotation speeded up, so that in 1940 the earth's position was 31 seconds ahead of what it would have been if the rate had continued as in 1900. Since the expected slowing down would have amounted to about 4 seconds, it is estimated that there must have been a 35 second gain due to the change in the moment of inertia.

Although the mean solar day is defective as a standard of time measurement, it has several practical advantages. One is that any person who is able to make astronomical observations can determine the time. Perhaps some day artificial timepieces will be produced which will rival the earth's rotation in uniformity, but, even so, they will probably be subject to interruptions in operation which will make it essential to refer them to celestial phenomena in order to secure continuity in the results.

There is no doubt that for the accurate observation of the earth's rotation the best method is that which utilizes the meridian transits of stars. Of course the results of solar observations must be utilized in the reduction of the results if solar time is to be determined, but the stars can be observed with more accuracy than the sun for the determination of time on a given date. Obviously the meridian is the best place for making the observations. It is true that some instruments such as the astrolabe give reasonably good results with observations which are not on the meridian, but the advantages of the best seeing, the elimination of corrections for refraction, simplicity of reductions, and instrumental stability are all on the side of meridian observations. The next question to be considered is where, on the meridian, observations may best be made. On this point there is some room for debate between the advantages of the equator and the zenith. At the equator the diurnal motion of the stars is the most rapid, but at the zenith the seeing is better and the azimuth error of the instrument is unimportant. Since the azimuth is the most difficult instrumental constant to determine accurately it is now generally considered that the zenith is preferable. It is of course not possible to observe exactly at the zenith, but the practice is to select a list of stars which are balanced as nearly as practicable around the zenith.

For the purpose of making the observations the instrument most used has been the meridian transit. If the transit instrument used is of the best type, of substantial size and rigid mounting, equipped with a motor driven self-recording micrometer of good design, and if the instrument is operated by thoroughly competent and careful personnel, it is believed

that the observational and instrumental errors may be so reduced in size as not to increase by very much the errors which are due to atmospheric causes. In case all the above conditions are not fulfilled, however, the errors of such instruments are apt to be considerable.

Since 1934 the Naval Observatory has been using a photographic zenith tube for the determination of time. This instrument consists of a rigid vertical tube which has a mercury basin at its lower end and an objective and plate carriage at its upper end. The light from the star passes through the objective, is reflected from the mercury, and comes to a focus on the photographic plate which is located immediately below the objective. The objective is so designed that its second nodal point lies in the plane of the photographic plate. In consequence of this fact the objective and plate, as a single unit, may be rotated about any horizontal axis through a small angle without displacing the image on the plate. This eliminates the effects of tube flexure and of errors in the level of the objective. Provision is made so that the objective and plate may be rotated together about a vertical axis through an angle of 180°. This operation of rotation is known as reversal, and it causes a displacement of the star image on the plate corresponding to the double zenith distance of the star. Reversals are made during the observation of each star. It is unnecessary to correct the observations made with the instrument for level or collimation errors, since the reflection from the mercury establishes the level and the reversal eliminates the collimation error. The azimuth or orientation may be determined by measurement of the images on the plate. The advantage of the zenith tube is that accurate observations are made with more ease and certainty than by means of the transit instruments. The disadvantage is that only those stars may be observed which pass very near to the zenith. In the latitude of Washington only about three stars per hour are available for observation, on the average, and considerable labor has been required in order to get satisfactory positions of most of those stars.

No matter what are the instrumental refinements, however, it is not possible to eliminate the effect of atmospheric disturbances from the observations. The atmosphere causes displacements in the apparent positions of the stars which vary continuously. These displacements may be regarded as composed of oscillations of a number of different frequencies, superimposed on one another. The oscillations which are most readily noticed as unsteady seeing have frequencies of the order of one per second. Their amplitudes are relatively large, but fortunately their effects tend to cancel out when observations of the same subject are continued for several seconds. It has been shown, however, that there are disturbances of much longer period. Schlesinger* says that there are oscillations of the order of one minute in length which have double amplitudes of about one second of arc. There are also oscilla-

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tions of much greater length, perhaps reaching to several hours or even throughout a whole night. Unfortunately there appear to be no data available which make it possible to say definitely what the probable error of a time determination from a single zenith star would be if the atmospheric unsteadiness were the only source of error. We can, however, set an upper limit to the effect. The total probable error of a time determination made from a single star with the zenith tube at Washington is about $\pm 0^s.009$, corresponding approximately to $\pm 0''.1$. The effect of the irregularity of the seeing can not exceed this quantity. It is believed that the seeing does account for most of the $\pm 0''.1$, so that if all other sources of error were removed the probable errors of the observations could not be reduced by as much as one half. There is one way in which the probable error, in units of time, could be reduced. If the instrument were placed at the equator, the errors due to the seeing, the plate measurements, and the errors of the instrument would all be reduced in proportion to the secant of the latitude. It is reasonable to suppose, therefore, that at the equator the probable error of a time determination from a single star would be about $0^s.007$, and that the weight of the observations for time would be increased to 1.66 times their weight at Washington.

Although the earth serves as our standard timepiece, the difficulty of observing the time according to it at any instant makes it necessary to employ secondary timepieces. For a number of years the standard clocks of the astronomical world were those made by Riefler. The excellence of those clocks was probably due more to their good workmanship than to their basic design. Over limited periods they often ran very well indeed, but they usually exhibited progressive changes in rate which made them of little use in studies extending over several months. This defect is present to a much less degree in the Shortt clocks, which have now taken first place as astronomical timepieces. They are capable of maintaining rates which remain uniform within one part in ten million for a year or more, and over shorter periods their daily rates may be predicted with errors which average only two or three thousandths of a second, or about three parts in one hundred million. Unfortunately these clocks have certain electrical and mechanical features which make it difficult to keep them in operation over long periods, and thus interfere seriously with their usefulness.

The problem of the precision pendulum clock is one which has interested many persons, and several of them have attempted to design timepieces which they hoped would be superior to the existing types. Probably some of the ideas were good, but none of them have produced clocks which are superior to the Shortt and which are produced commercially. Undoubtedly improvements on the existing pendulum clocks can be made and it is greatly to be hoped that capable men will continue to pursue the work.

In recent years a competitor with the pendulum as a timekeeper has

appeared; it is the quartz crystal. The crystal has certain properties which give it special advantages. Its internal friction is the least of any known substance. By taking advantage of the coupling which exists between the mechanical and electrical properties of the quartz crystal, it is possible to keep it in mechanical oscillation by electrostatic means. It is possible to so cut the crystal as to secure a zero temperature coefficient. Finally, the stability of the crystalline structure is great.

The Naval Observatory has been experimenting with crystal controlled timepieces for several years. It is too early definitely to judge what results may eventually be obtained, but already ratings have been obtained which are approximately equal to the best ratings so far obtained with pendulum clocks. There are certain other advantages for the crystals, such as their immunity to gravitational variations and earth tremors, and the fact that mounting piers and large temperature-controlled vaults are unnecessary. On the other hand the electrical power requirements are greater than with the pendulum clocks.

Taking into consideration the combined errors of time determination and time keeping, it is possible at the Naval Observatory at present to judge the time of an event which has just occurred with a probable error which may be estimated as about five thousandths of a second. The error of sending out time signals is a few thousandths greater, owing to the difficulties of operating the radio stations. The size of these errors has been reduced steadily during the past twenty years, and it is hoped that further substantial reduction may yet be possible.

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On the Origin of Novae

By WILLIAM A. LUBY

> "If we could make a reasonable proposition about what a nova is and why it exists we might be able to work out the inevitable consequences of our hypothesis and deduce spectrum changes which could be compared with those observed." (Dingle, "Modern Astrophysics," page 275.)

1. *Introduction.* For the last sixty years collision or explosion has in different forms been proposed as the cause of Novae. Random collision of a dark star with a bright one seems, however, to be ruled out by the result of Lindeman's calculations which show that there would have to be 4,000 times as many dark stars as bright ones to account for the known Novae. Moulton has made recently the following very significant comment.

> "At least ten Novae occur in our galaxy per year, and consequently at this rate more than twenty billions of them have blazed out during the geological history of the earth. Since there are probably not more than twenty billion stars in our galaxy, it follows either that all stars become Novae during intervals of time which are short in comparison with the lifetime of a star or that certain stars become Novae again and again." ("Consider the Heavens," pp. 216-217.)

2. *Binary Systems.* Lindeman's calculation was based on random collisions of a dark star with a bright one. Is any other type of collision possible? The answer is yes. One component of a binary (or multiple) system may be brought into collision with the primary by tidal friction. If M is the primary and m the companion, Moulton describes the two important conditions which lead to a collision as follows:

> "In the first the bodies move in the same direction, but the period of rotation of M is longer than that of revolution of m. Under these circumstances both periods are decreased, the relative amounts depending on the distance of the bodies from each other. If the bodies are initially far apart, the effect will be greater on the period of rotation of M than on the period of revolution of m, and the two periods will approach equality. But if the bodies are near together, the effect will be relatively greater on the period of m, the periods will not approach equality, and the bodies will ultimately collide. In the second case the rotation of M is in the direction opposite to that of the revolution of m. Under these circumstances M rotates faster and faster, the distance of m continually decreases and the inevitable outcome is the collision and union of the two bodies." ("Introduction to Astronomy," 1916, pp. 455-456.)

How numerous are the binaries? Aitken finds on the basis of present knowledge that one-third to two-fifths of the stars are binary or multiple systems. ("The Binary Stars," page 273.)

If collisions are imminent it seems likely that they would be in the spectroscopic binaries of short period and high velocity. Henroteau writes: "The periods of spectroscopic binaries run from a few hours to many years and the amplitudes of their velocities from three or four to three or four hundred kilometers." (*Handbuch der Astrophysik,* B VI S. 358.)

According to Moulton: "In most spectroscopic binaries the spectrum of only the brighter component is visible or measurable." ("Astronomy," 1930, page 436.)

It follows that the majority of spectroscopic binaries are bright stars with dark or relatively faint companions. Moreover, the numerous short periods show that many spectroscopic binaries are revolving in short periods, at high speeds, relatively close together.

Opik's studies indicate that each dwarf has four physical companions and each giant has three. Concerning the super-giants Henroteau writes: "There are indications that some super-giants have companions of relatively small mass."

The components of Krueger 60 are 0.18 and 0.27 as massive as the sun. Moulton writes: "It is highly probable particularly in view of the dark stars found in eclipsing binaries that there are many fainter binary stars having still smaller masses (than Krueger 60) but as yet they are unknown." ("Astronomy," 1930, page 434.)

It seems therefore reasonable to suppose that there were many close binaries in which tidal friction has already brought about a tangential collision and that in many such systems tidal friction is now at work bringing nearer the epoch at which a collision will occur.

3. *Hypothesis.* It will be assumed that a nova previous to its outbreak was a binary composed of a bright star and a small companion, presumably faint or dark. Further it will be assumed that the initial conditions were such that the companion was drawn in closer by tidal interaction until it made a tangential collision with the primary. It is the purpose of this paper to trace the consequences of this hypothesis.

It is clear that several companions might at different epochs be drawn into a star by tidal action. The increase in brightness of T Pyxidis in 1890, 1902, and in 1920 could be accounted for in this way. Moreover, this view is in harmony with Moulton's comment in Section 1 of this paper.

4. *Facts about Novae.* The facts known about novae previous to their outbreak are few. The observations do not show that any one was a double star. Russell, Dugan, and Stewart, "Astronomy," page 777, say: "Many of them were visible before the outburst as very faint stars which showed only small fluctuations in brightness." The parallaxes of five stars, Nova Persei, Nova Lacertae, Nova Aquilae, Nova Cygni, and Nova Geminorum have all been carefully determined and are very small. The mean visual magnitude of the five at maximum is 1.9 and before the outburst is 13.5. The corresponding *absolute* magnitudes are —3.1 and 8.5. One of these, Nova Persei, rose from below the eleventh magnitude to above the third in twenty-eight hours.

The character of the spectrum of very few novae before the principal outburst is known. For thirty years before its outbreak in 1918, Nova Aquilae was known as a very faint variable lying between the tenth and eleventh magnitudes with a spectrum of type A. (*Handbuch der Astrophysic,* Band VI, S. 265.) Davidovich states that the pre-maxima absorption spectra are generally characteristic of super-giant stars. With this statement Stratton agrees. (*Ibid.,* pp. 271-272.)

5. *The energy of the collision.* The velocity of the companion at the instant of contact depends on the mass and radius of the primary. It may have a value from about 200 kilometers per second to 600 or more. Suppose, *for the purpose of illustration,* that the mass of the companion equals the mass of the earth and its velocity at the instant of collision is 300 kilometers per second. The orbital velocity of a small companion revolving about Delta Cephei would be about 280 kilometers per second. The total energy of the collision can be calculated from the formula $E = mv^2/2$. This energy would be transformed into radiation and mechanical work. How the total amount would be divided between these two forms can be definitely indicated. The energy radiated by the sun is well known. It may be assumed that the energy of radiation of a zero magnitude star is approximately $(2.512)^{4.85}$ times the energy radiated by the sun. Using standard data the calculation follows: The kinetic energy of collision

$$E_1 = 5.974 \times 10^{27} \times (300 \times 10^5)^2/2 \text{ ergs} \qquad (1)$$

The sun is a star of magnitude 4.85 and it radiates (3.974×10^{33}) ergs per second. Hence the radiation of a star of zero magnitude is approximately

$$E_2 = (3.79 \times 10^{25})\ (2.512)^{4.85} \times 86{,}400 \text{ ergs per day} \qquad (2)$$
$$E_1/E_2 = 94.24 \text{ days}$$

For a star of magnitude —3, $E_1/E_2 = 5.945$ days. Hence, the energy of the collision equals the energy radiated by a zero magnitude star in about 94 days. For a star of magnitude —3 the period would be about six days. If the mass of the companion were sixteen times that of the earth the energy of the collision would be equal to the energy radiated by a star of magnitude —3 in about 95 days.

The time during which a nova remains near or at its initial brightness is only a very few days. Hence the results just given show that a companion having one-twentieth the mass of Jupiter would be sufficient to account for any nova not brighter than absolute magnitude —3 and only a small portion of the energy of the collision would be transformed into radiation thus leaving almost all of it to do mechanical work.

Similiarly, a companion of mass equal to that of Jupiter and a velocity of 300 kilometers per second at the time of the collision would account for novae of magnitude —6.

The major mechanical effect resulting from the collision would be the setting of the outer layers of the star in rotation and afterwards the lower layers as the planet sinks through them. If the companion is nearly spherical the motion would at first be imparted to a zonal belt surrounding the bright star. Friction would in time diminish the rate of rotation of the belt by imparting its energy of rotation to a lower layer then to a still lower one and ultimately to the whole star. The increase in the rate of rotation of the zonal belt and its decrease later should first broaden the spectral lines and later narrow them.

6. *The light changes of a nova.* The light curve of one nova is never identical with that of another. They exhibit, however, certain general likenesses. There is always a sudden rise to a maximum which in the case of Nova Herculis in 1934 was 170,000 times the original brightness. This is followed at first by a marked sudden fall. Thereafter, the fall is slow and irregular such that in a few years the nova returns to the magnitude it had prior to the outbreak. On the average the time required is about ten or twelve years.

On the hypothesis of this paper the sudden rise of the light curve would be caused by the tremendous mechanical disturbance of the outer atmosphere of the star by the companion at the time of and immediately following the collision. The magnitude of the energy here denoted by $mv^2/2$ and the calculations of Section 4 show that little of this energy is transformed into radiation and gives positive certainty that such a mechanical disturbance would be cataclysmic but of short duration.

The slow fall of the light curve and the attendant irregularities can best be understood in the light of the data in the following table which gives the volume of one cubic centimeter of water and one of iron at one atmosphere turned to gas at certain temperatures.

TABLE 1

Volume in cu. cm.	Material	Temp. in degrees C.	Pressure in Atmosphere	Volume of gas in cu. cm.
1	Water	100	1	1,700
1	Water	5,000	1	25,000
1	Iron	10,000	1	118,000

If the companion were of planetary density, when it sinks into a region of increasing density and rising temperature liquefaction of its surface material and its subsequent vaporization would result. The table shows clearly that vast masses of gas would for a time continue to form, move upward, and burst through the surface causing many small increases and decreases in light. As long as the companion keeps rotating and moving within the primary, friction would remove melted material from its surface. This material would then be rapidly vaporized. As soon as the companion stops rotating and moving, the melted material forms an insulating layer which retards the process of vaporization. Thus at first vaporization would be rapid and later it would be much slower. All these facts fit into a study of the light curve. Such variations as exist in these curves may be due to differences in the masses and the velocities of the companions, to differences in internal temperatures of the primaries, and to differences in the material of which the secondaries are composed.

If the companion were of density one or merely more dense than the primary, the results indicated by the table would then be far less marked.

7. *Roche's limit and possible tidal disruption of the companion.* It may be objected that Roche's limit is applicable to the two bodies and that tidal forces would disrupt the companion long before the tangential collision would take place. The precise conditions underlying Roche's theorem will be examined.

> "Roche proved that tidal forces would break up a *fluid* satellite of the same density as the planet around which it revolved if its distance were less than 2.44 . . . radii of the planet." (Moulton, "Introduction to Astronomy," 1916, p. 303.)

In the complete statement of Roche's Theorem 2.44r must be multiplied by $\sqrt[3]{(D \div d)}$ in which D is the density of the primary and d that of the companion. Therefore the companion on reaching the surface of Delta Cephei would be broken up by tidal strains if x satisfies the equation $x = 2.44r\sqrt[3]{(D \div d)}$ in which $D = .0006$ and $d = 4$. Solving this, $x = .0845r$. Therefore a companion having a density of even one would not be disrupted before the collision.

8. *Growth of a nebula around a nova.* Stratton says:

> "Here it seems likely that we have witnessed the actual movement of matter outward from the scene of the disturbance. The two brightest novae since Nova Aquilae in 1918, Nova Cygni in 1920 and Nova Pictoris in 1925, have both been observed to be surrounded by growing nebulous discs while Nova Ophiuchi in 1919 was found by Barnard to be imbedded in nebulosity. The normal rate of growth of these discs for the first year appears to be two seconds to three seconds a year." (*Handbuch der Astrophysic,* Band VI, 2 Teil, S. 292.)

Many novae exhibit after a time symmetrical nebulous envelopes. Barnard discovered one for Nova Persei sixteeen years after its maximum. For Nova Aquilae the photographs of 1927 show a nebulosity of circular outline.

Merrill says:

> "The outer strata seem somehow, possibly through light pressure, to have gone out of control of the main body of the star." ("The Nature of Variable Stars," page 94.)

It appears quite certain that high velocities in the line of sight greatly exceed the velocity of escape, $v = \sqrt{2gR}$, for the nova. For the sun the velocity of escape is about 615 km. per second while for Delta Cephei it is about 457 km. per second.

The high velocities in the line of sight as shown by the absorption lines are often far greater than either of these velocities. Any particle having a velocity greater than the velocity of escape which gets outside where motion is nearly unimpeded will move in an orbit around the nova. The steady growth of the nebula after the outbreak is evidence of this result. In this growth light pressure is undoubtedly an important factor.

The numbers in Table 1 indicate that explosive forces of very great magnitude would be at work and would be powerful enough to blow off the outer envelope to a considerable depth. This would account for the material in the nebulae around a nova. It would explain also the visible expansion of the disc around Nova Aquilae.

Accompanying this nebular growth there seem to be changes in the core of the nova. According to Hubble: Nova Aquilae, ten years after its outburst, had returned to the brightness it had before that event. Then it was a Class A star with a surface temperature of about 10,000 degrees Centigrade. In 1928 its spectrum indicated a temperature between 20,000 and 30,000 degrees. Yet the total luminosity was about the same as it was originally. Hubble explains this by supposing that the size of the star had shrunk just enough to compensate for the increased surface brightness.

9. *Spectral development of a nova.* The spectral development of a nova during its rise to maximum and afterwards is highly complicated. It may be presented simply by considering the spectral development of Nova Herculis. The spectral changes of this nova embody nearly all the difficulties.

Near maximum light the spectrum was of Class A similar to that of the super-giant α Cygni. Dark lines of hydrogen and other elements then appeared displaced toward the violet. This displacement corresponded to a velocity of approach of 1700 kilometers per second. The dark lines were bordered on the red side by very wide bright companions whose centers were not displaced.

Soon after maximum the spectrum changed to that of a B-type star. The new dark lines, still bordered on the red side by wide, bright lines, were shifted farther toward the violet. The shift corresponded to a velocity of approach of 2300 kilometers per second.

In general, the next change comes when the nova has become much fainter. The lines of the B-type spectrum vanish and the continuous background also. Then the bright lines appear which are characteristic of the bright line spectrum of a gaseous nebula.

Finally the spectrum becomes *analogous* to the spectrum of a Wolf-Rayet star. These stars are of Class O and are characterized by a faint continuous spectrum crossed by wide bright lines. These last are believed to arise in the gaseous envelope which is made fluorescent by high ultra-violet radiation. The strong ultra-violet radiation appears to indicate that the Wolf-Rayet stars are very hot.

Apparently the best explanation of these various changes is about as follows. The dark lines of the spectrum are given out by the central core of the star. They are displaced toward the violet because the absorbing material is moving toward the earth with high speed. In the case of Nova Aquilae in the A-type stage this was 1700 km. per sec. Later, in the B-type stage this was 2300 km. per sec. This change in velocity was due to the increase in violence of the explosive forces and to the increased velocity of the ejected gases.

The bright lines are the emission spectrum from the material moving outward from the star in all directions. The greater part of the nearer half of this material is rapidly approaching the earth and the greater part of the farther half is receding rapidly from it. Hence the resulting spectrum consists of very wide bright lines. The thinning out of the nebula by expansion and the diminishing light of the star explains the fading of the dark lines and the continuous spectrum. Finally the ordinary nebular lines appear and after a while they vanish and the nova spectrum becomes analogous to that of a Wolf-Rayet star.

The foregoing account is not final and is subject to revision. The following quotation emphasizes this:

"The expanding-shell hypothesis appears to give a good general account of the phenomena of novae, if it is assumed that the remaining core of the star is and remains exceedingly hot and emits intense radiation in the ultra-violet." (Russell, Dugan, and Stewart, "Astronomy," 1938, p. 941.)

On the same page is the statement: ". . . While the (unobservable) brightness in the remote ultra-violet may increase."

These quotations question in two important respects the likeness of post-novae to Wolf-Rayet stars.

It is agreed also that the emission of matter from a nova may not be in a uniform shell or shells. Certain non-uniform features have been observed and are referred to as "patchy clouds" or "knottiness" in the nebula.

A consequence of the hypothesis of this paper is forced rotation of the primary. This fact and the numbers of Table 1 indicate that nearly uniform ejection of material is possible if the secondary is not too dense. With a dense secondary the ejection would be non-uniform.

10. *Supernovae.* As many as a hundred novae of the familiar type have been detected in the Andromeda nebula by the observers at Mount Wilson. At their maxima these novae do not differ greatly in average absolute brightness from the average nova in our galaxy. Supernovae are, however, enormously more brilliant than ordinary novae. These have been discovered only in the exterior galaxies. Baade's summary of the supernovae of the last thirty years shows that their absolute photographic magnitudes at maximum were around —14.

Supernovae occur only at long intervals in any given spiral. In order to study the light curve they must be discovered near the time of their outburst. Hence systematic search was made in the Virgo Cluster where five hundred spirals can be photographed on a single plate. This was carried on at Mount Wilson and by Zwicky at the California Institute of Technology. On January 21, 1936, a supernova was discovered in spiral NGC 4273 by Dr. Hubble and Mr. Moore at Mount Wilson. It was then of magnitude —14.4. By February 16, its luminosity had diminished 60 percent. By the end of March its brightness was about 9 percent of what it was at first. Apparently the rapid rise and the rapid fall of the light of a nova is duplicated in that of a supernova.

It will be interesting to suppose that a supernova means a tangential collision of the type previously considered in which the mass of the secondary equals that of the sun and the velocity at the time of collision is 300 km. per second. As in Section 4, the energy $\frac{1}{2}mv^2$ of the colliding body is

$$E_1 = 1.983 \times 10^{33} \times (300)^2 \, (10^5)^2 \div 2 \text{ ergs}$$

The radiation of a star of magnitude —14 would be approximately

$$E_2 = (3.79 \times 10^{33}) \, (2.512)^{19.85} \times 86{,}400 \text{ ergs per day}$$

$$E_1 \div E_2 = 78.5 \text{ days}$$

Thus no change in the hypothesis is required to account for the supernovae. The velocity and mass considered are certainly within the limits possible in many close binaries in our own galaxy.

11. *Conclusion.* The established results of tidal friction and the known existence of many close binaries insure many tangential collisions in our stellar system. The various conclusions deduced from the hypothesis all have a dynamical basis. Dynamical conditions explain the

various features of the typical light curves of novae. It is interesting to note that without any change in the hypothesis supernovae are accounted for as well as novae. If the secondary is but slightly denser than the primary tidal disruption at or within Roche's limit of 2.44r cannot occur.

UNIVERSITY OF KANSAS CITY, KANSAS CITY, MISSOURI, AUGUST, 1940.

Destiny in the Stars*

By F. CHANDLER HARRIS

When Dr. Nicholas Murray Butler, President of Columbia University, returned from Europe in July, 1939, he told reporters that Hitler was apparently consulting astrology on his course of action. Said Dr. Butler, "It is apparently well known that Hitler is constantly in consultation with five astrologers who are reading to him the signs of the stars and telling him what lessons those signs have to teach. At the present time the advice of these wise men is that the climax of Hitler's career will come early in September and that whatever he is to do to add to his fame must be done before that date. This may sound like nonsense, but it is the sort of nonsense which may easily give to modern civilization another terrific shock."

If it was indeed astrological advice which led Hitler to plunge Europe into war on the first of September, 1939, then that date should be remembered as marking one of the greatest triumphs of nonsense in history. For scientists agree that astrology has no basis in fact, that it is not a science, and that it can be harmful to those who believe in it, just as any superstition can be harmful. I was discussing some of the astrological superstitions not long ago with Dr. Daniel Buchanan, Dean of the Faculty of Arts and Science and Professor of Mathematics and Astronomy at the University of British Columbia, Vancouver, Canada. He was a faculty member of the recent (1941) summer session on the Los Angeles campus of the University of California.

Dr. Buchanan says that many people confuse astrology with astronomy and suppose that there are reputable scientists who believe in it. Actually, astrology is an "art" equivalent to crystal-gazing or palmistry, and the application of astronomical data to the business of fortune-telling, Dr. Buchanan says, is like trying to use the Einstein theory to pick the winner of the sixth race at Santa Anita, California. A fortune-teller could see your future just as clearly by gazing into a $1.95 crystal ball as by peering into the multi-million-dollar 200-inch telescope of the Palomar Mountain Observatory.

It cannot be denied, however, that astrology has a large following and

*As presented over the N.B.C.'s Pacific Coast Red Network on the University Explorer program of the University of California, September 9, 1941. Communicated by Dr. Frederick C. Leonard, Chairman, Department of Astronomy, University of California, Los Angeles.

that its practitioners manage to collect considerable sums of money from the public. There are millions who believe in astrology to some extent, and hundreds of thousands who go so far as to spend money for horoscopes and predictions. There are some 10,000 astrologers of various sorts in the United States, and their yearly intake has been variously estimated at from $1,250,000 to $5,000,000. There are a number of astrological magazines, the largest of which is said to have a circulation of more than 100,000 copies. Some 250 newspapers throughout the country print daily articles on astrology, and many more carry horoscopes. Belief in astrology is by no means limited to romantic adolescents and eccentric adults—there are many prominent business and professional people so superstitious that they are afraid to act without having their astrologer consult the position of Saturn or Mars.

A few years ago one astrologer was getting $250 for a personal interview and from $1,000 to $10,000 for casting the horoscope of a corporation. This particular astrologer, incidentally, had made three separate million-dollar fortunes and lost all three of them, possibly on account of miscalculation of the messages of the stars on investments!

Dr. Buchanan says that the beginnings of both astronomy and its unscientific cousin, astrology, date back to the early Babylonians, who used the stars to determine the times of the inundations of their great rivers and to fix the seasons and the dates of religious festivals. All the happenings of their primitive lives were associated with celestial phenomena, and it was not strange that they should conclude that the heavenly bodies had a determining effect upon the fate of human beings.

The Babylonians supposed of course that the Earth was flat and fixed and at the center of the universe and that the Sun, Moon, and planets revolved around it in a narrow belt called the zodiac. At that time only five of the planets were known—Mercury, Venus, Mars, Jupiter, and Saturn. The Babylonians divided the zodiac arbitrarily into twelve regions and gave those regions names which became permanently fixed as the signs of the astrologer's zodiac. The planets were named after the heathen gods of the times and were assigned the supposed characteristics of those gods. Thus, Jupiter, the patron of Babylon, was the god of springtime. Venus, the chief goddess of Babylon, was the great mother, mistress of the lands and of fertility.

It was decided that these different planets should have different meanings according to what part of the sky they were in at the moment. Astrologers concluded that the particular distribution of the planets at the time of a person's birth would decide his life and character. Casting a horoscope is merely reassembling the planets as they were at the time of one's birth and then assigning some particular group of meanings to the arrangement. Dr. Buchanan says that assigning certain values to the planets is purely arbitrary, much as one might tell fortunes with a deck of cards, deciding that the Queen of Spades must mean death, the King of Hearts good fortune, the Jack of Clubs a handsome and mys-

terious stranger, and so on.

The credulous people of the Middle Ages, who believed in witches and sorcery, were easy marks for astrology, and even reputable astronomers were obliged to furnish astrological data for horoscopes, in order to earn a living. But three hundred years ago astronomy cast off its last connection with astrology, and since that time no recognized scientist has suggested that the stars shape the lives or the character of human beings. Astronomy has gone its way, making scientific measurements of the stars and planets, and astrology has continued along its original lines of soothsaying with pseudo-scientific trappings.

There have been, of course, certain changes in the astrological "art." For one thing, the astrologer no longer wears the pointed cap and the robe covered with glistening stars. Instead, he has an office in a modern building, preferably in a tall one so that he can be nearer the planets! If he is reasonably successful, he has a staff of secretaries and statisticians to compile astrological charts and data. The entire operation is carried on in a most business-like way, especially the collection of the fee, which may range from $5 to $500.

Astrology, also, underwent some change with the discovery of the new planets Uranus, Neptune, and Pluto. Since these planets were not known to ancient astrologers and had been assigned no meanings, it was up to modern practitioners to think up meanings for them. It was decided by one famous astrologer that Uranus should be in charge of railroads and that Neptune should govern aviation. Dr. Buchanan says that it is lucky that these heavenly bodies were not discovered by the Babylonians, because the planets in question would have been unemployed for centuries, while waiting for railroads and airplanes to be invented!

Even today there is considerable disagreement among astrologers as to just how the stars should be read. Some practitioners ask only the date of the client's birth; others must know the exact hour and minute. Many insist that the geographical location of the birth, also, is important, since the position on the globe would slightly alter the observed relationships of the planets. Aside from those slight differences, though, astrologers are agreed that the positions of the planets at the time of a person's birth are the determining influences of his life and that a study of these positions will indicate his character and his future health, wealth, and happiness. If this contention were true, two babies born of different parents in the same city at the same moment would be identical in characteristics and prospects! Astrologers believe also that they can predict such happenings as wars, great fires or floods, and other catastrophes.

Since astrologers make many predictions, it is not astonishing that some of them should be right, merely on a percentage basis. If one cuts a deck of cards often enough, the ace of spades will eventually be cut purely by chance. One famous astrologer got her start by telling a

hotel owner that he would soon meet with disaster. Shortly after that, his hotel caught fire. He told newspaper reporters about the prediction, and the astrologer was on her way to fame and fortune.

Astrologers point always to their successes and conveniently forget their failures, Dr. Buchanan observers. Hordes of astrologers tendered expert predictions that the child of Anne Boleyn would be a male, but the child was christened Elizabeth! Near the close of the twelfth century, in 1186, Europeans were in a turmoil as a result of astrological predictions that a conjunction of planets in the windy constellation of Libra would produce a cataclysmic windstorm. It was said that cities in sandy regions would be completely buried. Panic-stricken people built underground shelters, but the fateful month of September came and went without any undue meteorological disturbance.

Modern astrologers, too, have had bad luck on occasions. At a meeting of English practitioners in 1936, a prediction was issued that the European situation would be settled peacefully. In 1939, a well-known English operator read in the stars that English taxes would be lower in 1940, on account of a slackening in arms production. One of the best-known astrologers on the Pacific Coast predicted that Hitler would be assassinated in 1940 and that the Maginot Line would never be broken.

From time to time scientists and others have attacked astrology with varying success. Swift, the famous satirist, forecast the death of Partridge, the foremost astrologer of his day. When the date of Partridge's supposed death had passed, Swift announced that the prediction had been fulfilled. Partridge indignantly denied that he had died, but Swift said that he was no gentleman to doubt the validity of his own science and that proof was wholly irrelevant!

Recently a frontal attack on astrology has been launched by the American Association of Scientific Workers under the leadership of Dr. Bart J. Bok, Associate Professor of Astronomy at Harvard University. Dr. Bok has issued a preliminary report surveying the hold of astrology on the gullible and pointing out some of the reasons why scientists put absolutely no faith in astrological practices. He says that scientific studies have shown that the amount of radiation from the stars and planets which reaches the Earth is exceedingly small and that the gravitational effect of these bodies is negligible in comparison with that of nearby objects. For instance, under only the most favorable conditions at the time of a child's birth can the gravitational effect of the planet Mars equal that produced by the doctor in charge of the delivery. If gravitational force is really important, perhaps the whole life of the child depends upon the weight of the doctor! Dr. Bok disparages also the astrological doctrine that the planets influence our lives by "vibrations," as astronomers have never found any evidence to indicate that the planets are "vibrating."

Of course, the only way astrology could be scientifically disproved once and for all time would be to analyze thousands of horoscopes from

the foremost astrologers to see whether their predictions come true. Such an experiment has never been carried out, primarily because there is no such mass of data readily available and because no scientists have taken astrology seriously enough to go to the trouble. However, some lesser studies have been made by accredited research experts. Dr. Bok cites the Farnsworth study of the zodiacal birth-signs of some 2000 musicians and painters. Most astrologers agree that those born under the sign of Libra should have musical or esthetic talent, but it was found that these artists' birthdays ranged throughout the year, just as do the birthdays of ordinary persons. If anything, the births of artists under the sign of Libra were less than the average. A member of the Bok committee ran an analysis of the birthdays of men listed in "American Men of Science," and found that these, too, were distributed normally throughout the twelve months.

On a smaller scale, other investigations, also, have rendered negative verdicts. Otto Bobertag asked the most prominent German astrologers to cast horoscopes for a group of men about whom he had complete information. He found that different astrologers cast different horoscopes for the same man and that none of them was right.

In the light of such results, it is not surprising that men of science should be unanimous in their condemnation of this spurious art. Perhaps a typical statement is that of Dr. Harlow Shapley, the Director of the Harvard College Observatory. He says, "Star-reading is plain buncombe. The stars, despite queer notions to the contrary, have as little influence on our daily lives as the leaves in a cup from which you drink your tea. And yet some people believe in that, too!"

Professor Frank Schlesinger, the Director Emeritus of the Yale University Observatory, declares, "If there were any basis for astrology, astronomers would be glad to know of it. Some have looked into it. I have, and I have come to the conclusion that there is no basis for its claims." As to the astrologer's assertion that the art is of use to physicians in diagnosing the ills of a patient, Dr. Morris Fishbein of the American Medical Association says, "Astrology is 'the bunk.' There are no good doctors who use astrology in any way, shape, manner, or form."

To counteract such straightforward condemnation, some astrologers put out word-of-mouth propaganda. When *Good Housekeeping* magazine was making an investigation of astrology recently, an astrologer told the investigator for the magazine that a large American airline had horoscopes prepared for all its pilots and sent the pilots up or kept them down, according to the signs of the zodiac. Investigation proved this assertion to be untrue.

But in spite of the weight of science and scientists, astrology continues to thrive. The economic loss is bad enough, but the harm done to the victims of astrology is even more far-reaching, as Dr. Buchanan points out. People sometimes follow their horoscopes rather than com-

mon sense and meet with disaster. There are cases on record where people have died rather than take medical treatment because it was not the right astrological month for an operation.

Astrology is bad for the mind as well as for the body, as indicated by a recent statement of the Society for Psychological Study of Social Issues. The psychologists say, "Faith in astrology or in any other occult practice is harmful in so far as it encourages an unwholesome flight from the persistent problems of real life." Those who rely upon astrology are using an opiate of the mind, for they have substituted the abracadabra of a counterfeit science for the labor of thinking.

Department of Radio Broadcasting,
University of California, Los Angeles

Planet Notes for March, 1942

By R. S. ZUG

Note: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from *The American Ephemeris and Nautical Almanac.*

Sun. Apparent positions of the sun for March 1 and March 31, respectively, are: $\alpha = 22^h\ 45^m.3$, $\delta = -7°\ 54'.4$; $\alpha = 0^h\ 35^m.4$, $\delta = +3°\ 49'.3$. The sun will move from the constellation Aquarius into the constellation Pisces on March 12. Spring begins March 21, $6^h\ 11^m$, the instant when the sun reaches the vernal equinox.

Moon. Phenomena of the moon will occur as follows:

		h	m
Full Moon	Mar.	3	0 20
Last Quarter		9	22 0
New Moon		16	23 50
First Quarter		25	0 1
Perigee	Mar.	8	11
Apogee		23	10

Eclipses. A total eclipse of the moon will occur March 2-3. The beginning of the eclipse will be visible in Europe, Asia, Africa, and the Atlantic Ocean, but not in the United States. For observers in the United States the moon will rise after the eclipse has begun. Circumstances of the eclipse are as follows:

		G.C.T. h	m
Moon enters penumbra	Mar. 2	21	27.6
Moon enters umbra	2	22	31.3
Total eclipse begins	2	23	33.2
Middle of eclipse	3	0	21.5
Total eclipse ends	3	1	9.8
Moon leaves umbra	3	2	11.5
Moon leaves penumbra	3	3	15.0

A partial eclipse of the sun will occur March 16-17. The eclipse will be visible over portions of Antarctica and the South Pacific Ocean, but from practically no inhabited land area of note except Easter Island.

Mercury. Mercury will be a morning star at greatest elongation on March 8. The planet will at that time be 15° south of the celestial equator, and consequently will be rather inconspicuous for observers in the northern hemisphere.

Venus. Venus will be a brilliant morning object during March, although 12° south of the celestial equator. A maximum brightness corresponding to stellar magnitude —4.3 will be attained on March 9.

Mars. Mars will be an evening star of stellar magnitude +1.1 on March 1, after which, by the end of the month, the brightness will have diminished by 0.4 of a magnitude. The north pole of Mars is now coming into view, and the Martian season of spring has just begun. The angular diameter of the planet will be about 5″.5 during March. The planet will be moving eastward in Taurus, about 5° to the south of the Pleiades as the month opens. On March 2, 7^h, Mars will be in conjunction with, and 1° 37′ to the north of, the planet Uranus.

Jupiter. Jupiter reaches western quadrature on March 3. The planet is moving slowly eastward in the constellation Taurus, and will appear as a star of magnitude —1.8 in brightness.

Saturn. Saturn will be an evening star of stellar magnitude +0.4, situated about 10° south of the Pleiades. The major axis of the ring system now subtends an angle of 39″ and the minor axis an angle of 15″.

Uranus. Apparent positions of Uranus for March 1 and March 31, are, respectively: $\alpha = 3^h\,37^m.5$, $\delta = +19°\,13'.4$; $\alpha = 3^h\,41^m.6$, $\delta = +19°\,27'.5$. Uranus will be situated 1° 37′ to the south of Mars on March 2.

Neptune. Neptune will attain opposition on March 19. The planet is situated in the constellation Virgo, and at opposition will be found about 2½° east of, and about ½° to the south of, the +3.8 magn. star Virginis.

Occultation Predictions for March, 1942

(Taken from the *American Ephemeris*)

Date 1942		Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
				h m	m	m	°	h m	m	m	°
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′											
Mar.	2	56 Leo	6.0	22 46.9	0.0	+0.5	118	23 43.1	—0.2	+1.2	273
	3	*c* Leo	5.1	1 10.4	—1.0	+3.4	56	1 51.2	—0.8	—2.3	343
	3	*β* Vir	3.8	23 58.3	—0.1	+0.1	130	0 52.2	—0.4	+1.4	267
	5	38 Vir	6.2	5 6.0	—1.4	—0.3	122	6 22.7	—1.7	—0.4	291
	8	190 B.Lib	6.4	6 46.9	—2.2	+3.0	52	7 25.6	—0.2	—2.0	347
	9	24 Sco	5.0	6 36.0	—0.3	—1.4	138	7 33.0	—1.4	+1.5	252
	11	89 G.Sgr	6.5	7 45.1	+0.2	—0.8	150	8 21.6	—1.5	+2.9	219
	11	B.D.—19°5182	6.4	10 55.5	—1.8	+0.6	94	12 15.8	—1.9	+0.2	263
	19	64 Cet	5.7	22 55.1	—0.9	—0.9	79	0 4.1	—0.5	—0.7	248
	20	ξ^1 Cet	4.5	0 4.2	—0.5	+0.3	43	0 57.2	0.0	—2.1	288
	22	*α* Tau	1.1	22 0.8	—1.9	+1.9	46	23 15.1	—1.9	—2.3	294
	25	292 B.Ori	6.5	2 6.0	..	..	172	2 24.4	..	..	200
	26	2 B.Cnc	6.2	21 53.8	—1.5	+1.7	77	23 13.5	—1.9	—0.6	296
	26	5 Cnc	5.9	23 57.7	—2.3	+1.4	69	1 11.8	—1.7	—2.4	315
	30	80 Leo	6.4	21 57.0	—0.1	+0.5	116	22 55.8	—0.5	+1.0	279
	31	89 Leo	5.8	2 46.6	—1.7	—0.2	110	4 5.4	—1.6	—1.2	302

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′

Mar. 3	*c* Leo	5.1	0	54.2	—0.2	+2.2	68	1	41.7	—0.6	—0.8	326
5	38 Vir	6.2	4	49.6	—0.6	—1.1	150	5	47.9	—1.7	+1.4	259
8	190 B.Lib	6.4	6	18.1	—0.7	+1.4	87	7	17.7	—0.6	—0.1	311
9	24 Sco	5.0	6	47.5	..	..	189	6	53.1	..	..	200
11	B.D.—19°5182	6.4	10	28.3	—1.1	+0.6	111	11	39.1	—1.7	+1.1	254
22	*a* Tau	1.1	21	22.4	—1.5	+3.0	40	22	37.6	—2.6	—1.2	291
26	5 Cnc	5.9	23	17.9	—1.7	+1.6	79	0	40.0	—2.0	—0.7	296
31	89 Leo	5.8	2	22.0	—1.1	—0.7	136	3	32.7	—1.8	+0.6	272

OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′

Mar. 4	Neptune	7.7	4	48.3	..	..	48	5	16.9	..	..	355
5	*k* Vir	5.9	7	39.1	—1.7	+0.8	94	8	50.0	—1.3	—1.2	320
6	598 B.Vir	6.5	8	13.8	—2.4	+2.9	61	8	55.8	—0.2	—2.8	351
6	623 B.Vir	6.5	14	14.6	—1.2	—1.2	100	15	22.9	—0.8	—1.8	295
6	95 Vir	5.5	15	32.9	—0.6	—0.6	72	16	25.3	—0.5	—2.2	318
31	89 Leo	5.8	2	8.8	—0.3	—3.2	172	2	38.0	—0.9	+4.2	226

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

In the table which forms a large part of these notes I have recorded the 1941 observations, most of which can be used for hourly rates and which so far remain unpublished. Of course, some others are likely to come in later but there is reason to believe their number will be small. As to comments on the table's contents it may be said that Michigan led all other states, mostly due to Paul Anderson and W. A. Borden, who reported 1001 and 1256, respectively, nearly every one plotted and with full tabular data given. Anderson particularly seems to have the ability to see a larger proportion of fainter meteors than most observers, which, along with clear skies, accounts for his higher rates. R. M. Dole's report that on one hour's watch for each of six nights during the Orionid epoch (see table) he saw no meteor whatever is extremely unexpected and strange. He had similar bad luck last April (see June "Meteor Notes") when he saw no Lyrid during 12 hours of observing over 6 nights. This time, however, he reports seeing no meteor of any kind.

Certain reports that come to me are of an unusual nature and deserve quoting at considerable length. Unfortunately, most such phenomena are seen by only one person so confirmatory observations are not at hand. Cases, however, which seem on their face improbable, are simply suppressed here, but the most unexpected things do happen with meteors and hence unusual observations bearing all the evidence of authenticity should be made matters of permanent record.

The first letter, from J. B. Saunders of Alexandria, Va., was addressed to me personally and was written on 1941 December 11.—"I wish to report an unusual meteoric display seen December 10 around 8:30 P.M., E.S.T. On looking up, a horde of meteors were seen somewhere between the star Eta Eridani and Nu Tauri, moving in direction of Beta Geminorum. They passed very near Zeta Tauri. The number decreased very rapidly, as they burned out, from an estimated number of about 60. The brightness of the individual bodies ranged from the faintest to several of zero magnitude . . . (estimate) 3 of 0 magn., 8 of 1 magn., 20 of 2 magn., . . . others to faintest visible. The average angular velocity . . . about 10 degrees per second. The paths covered a space less than 2° wide. The last one visible, disappeared near Beta Geminorum. The paths were all parallel and each of the larger bodies left a trail of from 1° to 3°. The spatial distribution may be described as made up of two groups, covering an area of approximately 5° along the path; a smaller group with a bright meteor leading, preceding a larger group. However the separation was not well defined . . . "

It seems certain that such a remarkable display must have been noted by other intelligent people and I urge that if this note comes to their attention they will take the trouble to write me about what they saw.

The second communication was addressed to the U.S. Naval Observatory and was sent to me by the Superintendent. This was written by Axel L. Jacobson of Ironwood, Michigan. "... On the morning of January 3, 1941, at 5:20 o'clock I witnessed an unusually heavy fall of meteorites. There was a regular rain of small meteorites from the vicinity of Ursa Minor. These meteorites were extinguished high in the heavens. There were hundreds of them in this particular fall which lasted about 3 minutes. The larger meteors which appeared to reach the earth came from overhead and to the east. These larger meteorites fell at the rate of 4 or 5 at a time at about 30-second intervals for 35 minutes. One fell close enough to me that I put out my hand and tried to catch it. The air was unusually clear that morning and the stars were bright. I haven't seen any record of this fall, and I am wondering if this was something unusual. . . "

As is well known, the Quadrantids are in activity on the date in question. It is also known that small groups of meteors furnish showers which are very local and sometimes brilliant. This second letter is written in long-hand and is obviously a straightforward attempt to describe a remarkable phenomenon. That an untrained observers should be deceived as to the nearness of a meteor has often happened before, so I give the report as received by me, again hoping that it may reach the attention of some other person who can give us additional data on what happened. Referring to the report of Mr. Saunders, there is a strong resemblance in what he saw to the famous Meteoric Procession of 1913 February 9.

In the December "Meteor Notes," p. 549, attention was called to 7 bright meteors reported for the night of 1941 October 22/23. Since preparing those notes reports on 6 other fireballs have come, all of which were observed on or near this date. They are as follows, G.C.T. being used for the sake of uniformity:

Oct. 21	0:21	In Kentucky
21	6:	In California
22	2:55	Off New Jersey Coast
21	23:03	In Pennsylvania
23	1:30	In South Atlantic Ocean
23	1:30	In Indian Ocean.

R. M. Dole, reporting for R. L. Day, says as follows: "S.E. 1000 of Bermuda

saw a brilliant shower of Orionids October 22, 14:00 to 16:00." This would be morning of October 23 by G.C.T.

We welcome the following new members who joined during 1941:

Maher, J. ., 211 E. Wood St., Versailles, Ohio.
Fortner, L. E., 805 Nalle St., Charlottesville, Va.
Stewart, Miss M. F., Box 6542 T St. Station, Washington, D. C.
National Capitol Amateur Association, C. A. Peterson, Treas., 4845 V St., Washington, D. C.
Beck, Mrs. M., 168 Vendome, Grosse Pte., Farms, Mich.
Reber, M. A., 116 S.E. 38 St., Oklahoma City, Okla.
Singer, R. M., 1870 Midwich Drive, Altadena, Calif.
Woodburn, J. J., 3722 N. Grate St., Philadelphia, Pa.
Powell, K., 708 Line Ave., Elwood City, Pa.
Heilman, C. E., Elizabethtown College, Elizabethtown, Pa.
Hayek, M., 226 Oakey Ave., Lawrenceburg, Ind.
Hayman, R., 122 Brown Ave., Carey, Ohio.
Mount Holyoke Observatory, South Hadley, Mass.
Fernald, C. F., Wilton, Maine.

Three of our regional directors have changed their addresses. The correct ones follow:

Prof. B. S. Whitney (for Oklahoma and Kansas), Observatory, Univ. of Okla., Norman, Okla.

Geo. E. Lambert (for Hudson Valley and adjacent regions), 716 South St., Peekskill, N. Y.

J. Wesley Simpson (for Florida, S. Georgia, and West Indies), 921 N.W. 17 Court, Miami, Fla.

Station and Observer	Date 1942	Began	Ended	Int.	Met.	Rate	F.	*
Beechwood, Mich., Anderson P.	Jan. 0	12:16	13:16	60	10	10.0	1.0	
	19	6:38	8:00	55	7	7.6	1.0	
	23	7:05	8:40	60	2	2.0	1.0	
	31	10:27	11:27	60	6	6.0	0.9	
	Feb. 23	8:20	9:00	40	10	15.0	1.0	
	24	7:40	9:25	40	1	0.7	0.9	
	27	8:00	10:02	90	16	10.7	1.0	
	28	8:00	14:00	65	16	14.8	0.8	
	Mar. 3	7:37	8:07	30	9	18.0	0.8	
	4	7:50	8:30	40	9	13.5	0.8	
	5	7:50	8:30	40	8	12.0	0.7	
	6	7:49	8:29	40	8	12.0	0.7	
	18	7:32	8:12	40	7	10.5	1.0	
	24	7:53	8:43	50	9	10.9	1.0	
	25	7:50	8:50	60	10	10.0	0.8	
	26	8:50	9:20	30	6	12.0	1.0	
	28	12:14	13:24	60	15	15.0	0.9	
	Apr. 1	8:39	9:39	60	9	9.0	0.9	
	2	8:05	9:10	65	9	8.3	0.8	
	4	10:55	12:40	90	21	14.0	0.8	
	5	14:00	14:45	45	11	14.7	1.0	
	6	8:00	9:00	60	9	9.0	0.6	
	Sept. 23	9:35	10:05	30	5	6.0	0.6	
	Oct. 14	9:00	10:30	90	12	8.0	0.9	
	18	10:25	11:25	60	8	8.0	0.9	
	21	12:50	13:50	60	12	12.0	0.8	
	Nov. 14	17:15	18:00		5		0.6	
	23	9:20	10:50	90	18	12.0	1.0	
	24	9:30	13:30	240	44	11.0	0.8	
	Dec. 6	10:15	12:15	120	12	6.0	0.5	
Binghampton, Mich., Borden, W. A.	July 30	10:40	12:35	115	33	17.2	0.5	
	31	9:50	12:55	185	60	19.5	0.7	

Station and Observer	Date 1942	Began	Ended	Int.	Met.	Rate	F.	*
	Aug. 1	11:30	13:50	140	67	28.8	0.6	
	6	9:15	11:00	105	33	18.9	0.7	
	15	10:50	12:20	130	27	12.5	0.7	
	16	11:15	11:45	30	9	18.0	0.4	
	17	9:15	11:15	120	23	11.5	0.4	
	22	11:30	13:40	130	41	18.9	0.7	
	23	12:55	14:40	115	60	31.2	0.5	
Champaign, Ill., Tapscott, C.	Jan. 20	10:35	12:15	100	3	1.8	0.7	
	31	10:51	12:20	89	4	2.7	0.7	
	Feb. 19	10:37	11:42	65	7	6.5	0.9	
	20	10:41	12:02	81	4	3.0	0.8	
	23	10:47	12:35	108	9	5.0	0.7	
	25	10:55	12:25	90	7	4.7	0.8	
	Mar. 20	10:44	12:25	101	9	5.4	0.8	
	21	10:49	12:30	101	11	6.6	0.8	
	22	11:28	12:28	60	4	4.0	0.7	
	24	10:45	12:13	88	8	5.4	0.9	
	26	10:37	12:21	104	8	4.6	0.8	
	Apr. 16	10:35	11:30	55	2	2.2	0.5	
	17	10:45	11:30	45	2	2.7	0.5	
	20	10:42	11:35	53	5	5.7	0.5	
	21	10:37	13:07	150	11	4.4	0.9	
	May 19	9:29	11:29	107	11	6.2	0.8	
	23	10:13	12:01	108	7	3.9	0.9	
	24	10:40	11:57	77	6	4.7	0.8	
Cape Elizabeth, Me., Dole, R. M.	Aug. 24	9:00	11:00	120	44	22.0		
	Oct. 17	11:00	12:00	60	0	0.0		
	18	11:00	12:00	60	0	0.0		
	19	11:00	12:00	60	0	0.0		
	20	12:00	13:00	60	0	0.0		
	21	12:00	13:00	60	0	0.0		
	23	12:00	13:00	60	0	0.0		
	Nov. 17	14:00	16:00	120	2	1.0		(1)
	Dec. 14	12:00	13:00	60	7	3.5		(2)
S.E. of Bermuda, Day, R. L.	Aug. 24			"Many"				
	26			"Brilliant Showers"				
	Oct. 22	14:00	16:00	120	"Brilliant Showers"			
	Dec. 12	14:	17:		"Fine Shower"			
Santa Barbara, Calif., Stone, R. M.	Jan. 0	11:30	13:30	120	0	0.0		
	1	11:30	14:00	150	6	2.4		
	2	11:00	15:00	240	21	5.2		
Grandview, Tenn., Jewett, Miss M.	Nov. 13	14:30	15:00	30	0	0.0	0.7	
	14	12:30	13:30	60	6	6.0	1.0	(3)
	15	15:00	16:10	70	3	2.6	1.0	
Somers Point, N. J., Woodburn, J. J.	Aug. 28	8:45	10:30		6			
					22			(4)
Philadelphia, Pa.	Dec. 14	7:15	9:00		9			
Joliet, Ill., Preucil, F.	Dec. 13	12:30	13:00	30	21	42.0	1.0	(5)
Falls Church, Va., Feldman, R. L.	Dec. 13	9:30	10:		30±10	20.0		(6)
New Waterford, Ohio, Haas, W. H.	July 17	10:21	12:08		90±17		1.0	
Toppenish, Wash., Thompson, Miss B. J.	Nov. 15	12:30	13:30	14	60	14.0	0.8	(7)
Kanaya, Japan, Komaki, K.	Apr. 22	14:55	16:05	70	13	11.1	0.8	(8)
	24	15:04	16:04	60	10	10.0	0.7	
	May 1	15:12	16:02	50	11	13.3	0.7	(9)
	4	14:43	15:53	70	23	19.7	0.7	(10)

NOTES: (1) Leonids, (2) Geminids, (3) From window; counts, (4) Casuals, (5) 14 Gem, (6) Count, (7) Count, 13 Leonids, (8) 5 Lyrids, (9) 4 η Aquarids, (10) 20 η Aquarids.

We again earnestly request those members who have not paid their 1942 dues to please do so thus saving us the time and expense of mailing bills. Also, anyone who has unreported observations should kindly send them in by March 1 at latest, so they can be included in the annual report.

As a number of our most active observers are now in military service, to their honor, the rest of us, who are not so serving our country due to age, sex, physical disability, or orders from the Government to serve in other capacities, should strive to make good the handicaps of the A.M.S. that come from war. Some work on the part of those who did absolutely nothing in 1941, and more work on the part of those who did but little, would go far towards making up our inevitable losses. Also it is generally conceded that our country will profit from the prosecution of scientific work by all who are interested in it and able to do it. Will not our A.M.S. members then do their part in upholding morale, for that is what will result in the long run, as well as in aiding in the advance of meteoric astronomy.

Flower Observatory, Upper Darby, Pennsylvania, 1942 January 17.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles

President of the Society: LINCOLN LA PAZ, Department of Mathematics, Ohio State University, Columbus

Secretary of the Society: C. H. CLEMINSHAW, Griffith Observatory, Los Angeles, and Department of Astronomy, University of Southern California, Los Angeles

A New Aerolite from Stonington, Colorado

By JOHN DAVIS BUDDHUE
99 South Raymond Avenue, Pasadena, California

ABSTRACT

The time, exact location, and circumstances of the finding of an aerolite from Stonington, Colorado, are not known. The stone is an old fall heavily impregnated with oxide, but most of the crust remains. The original weight was about 6 lb. The specimen is a chondrite of type *Cka* and contains about 20% metal and troilite. Of the silicates, 42% are soluble and 37% insoluble.

The Stonington aerolite was found on a farm belonging to Mr. Clarence Davis, 4 miles south and 1 mile east of Stonington, Baca Co., Colorado. This position is approximately long. W. 102° 42′, lat. N. 37° 17′. Accordingly, the find is designated as number 1027373 in the system proposed by Dr. Leonard.[1]

The stone was brought to my attention by a Mr. E., who wishes to remain anonymous. He says that he has been unable to determine precisely who found the stone, when it was found, and where. He is certain that it was found on Mr. Davis's farm, and is reasonably sure that it was found by Mr. Davis himself on a "blown-off ridge, ½ mile west of the house." It was regarded as a "volcanic stone" until it was given to Mr. E., who thought that it might be a meteorite. The original weight was about 6 lb. (2.72 kg.), but, judging from Mr. E.'s snapshots, I infer that it was not entirely crusted. Its shape is roughly that of an oblique,

triangular pyramid. There are no flight markings and some of the edges are quite sharp.

The crust is perhaps 0.2 mm. thick and dark brown, almost black, in color. Veins in the stone appear as slight ridges on the surface. The crust has a slight luster, irregular contraction cracks, and, altho neither rough nor scoriaceous, it is not smooth and is evidently derived from at least 3 constituents of different fusibilities. The least fusible of these has formed rounded tubercles over the entire surface.

The interior of the stone is abundantly fissured. Some of these cracks are doubtless pre-terrestrial in origin, but others are just as clearly the result of the rusting of the metal. Mr. E. has kindly presented me with an end slice weighing 238 g. One large crack has completely divided this slice into 2 pieces, one weighing 136.7 g. This piece is slightly lighter in color than the other, and a sulfur-print shows that troilite is 2 or 3 times as abundant in this as it is in the other part. Visually, the metallic-appearing particles may be slightly larger, but they are everywhere abundant, tho small. On close examination, about 50% of them are found to be troilite. All are extremely irregular, and frequently several are grouped so as more or less to envelop a chondrus or crystal fragment. I do not regard this stone as a breccia of 2 different types. The differences between the 2 parts are due probably to differences in the extent of oxidation.

The fall is an old one, as the stone is heavily impregnated with oxide. The color of the interior has, probably always, been dark, but it is now only slightly lighter than the crust. Near the larger oxidation cracks there is a readily discernible decrease in the number and the size of the metallic-appearing particles, and a sulfur-print shows that troilite is virtually absent from these areas. This phenomenon is found also in the Covert, Kansas, stone.

Mr. E. originally sent me a 27-g. fragment for identification. A thin section was made from a part of this. Here again the weathered condition of the stone was most evident. Nothing that was certainly troilite could be found, and all of the iron particles were coated with thick layers of black oxide. Altho the stone is very hard, the silicates are in a shattered condition. There are numerous rounded masses which may be either rounded crystals or imperfect monosomatic chondri; it is difficult to say which. These and the true chondri are embedded in a fine-grained mass of crystal fragments and oxide.

There are many small, mostly imperfect, chondri composed for the most part of clusters of imperfect crystals. There are also some larger, more nearly perfect, chondri, about half of which are of the radiating-enstatite type. Some of these radiate from more than one center. Most of the rest are composed of masses of small crystals or of cryptocrystalline enstatite. Only 2 barred olivine chondri were found. The less perfect one is 0.6 mm. in diameter and partly inclosed in a very narrow secondary border. The other is a tolerably good hexagon measuring 1.1×0.8 mm. Each side is composed of a group of olivine bars, and most of the interior is occupied by another group of bars parallel to one diagonal, altho there are a few crossing these at 60°. The space between the bars is filled with a material resembling that composing the cryptocrystalline enstatite chondri but part of it is isotropic like glass. This grades gradually into anisotropic areas.

On the whole, the stone seems to correspond to Brezina's veined crystalline chondrite (*Cka*).

On account of the oxidized condition of the stone, a complete analysis was not thought worth the expense. A proximate analysis, however, gave the following results:

Insoluble silicate	37.55%
Soluble silicate	42.35
Metal + troilite	19.67
Moisture	0.36
Total	99.93%

The insoluble silicate was a gray powder. The soluble silicate contained MgO + CaO, calculated as MgO = 45.35%. The metallic portion yielded:

Fe	94.37 %
Ni	5.57
Co + Cu	0.237
Total	100.177%

The iron content appears to be somewhat high, probably on account of the inclusion of troilite. Troilite could not be determined separately because, in spite of the usual precautions, acid produced a strong odor of hydrogen sulfide. There was, therefore, no point in determining sulfur.

A part of the meteorite was tested for ionoluminescence by a method described elsewhere.[2] As usual with dark-colored stones, the exposure to cathode rays and other ions produced only a weak phosphorescence. The fluorescence, likewise, was not particularly strong, but this specimen produced more colors than any previously examined stone. Only about one-third of the exposed area luminesced. The luminous spots were scattered uniformly over the surface and consisted presumably of enstatite. It should be noted that about one-third of the stone is insoluble silicate. Both fluorescence and phosphorescence were pale bluish-white in color, the former being the brighter. In addition, there were numerous brilliant green points scattered all over the specimen. Several small areas with a red fluorescence also were found. These were less brilliant than the similar ones previously noted in stones from Holbrook, Arizona, and Bishopville, South Carolina.[2] At first there was one spot about 1 mm. square with a bright yellow fluorescence and a very short-lived phosphorescence, but some weeks later this spot could no longer be found. A total of 4 colors was observed.

On warming this specimen, gas was evolved. The most outstanding lines in the spectrum were the carbon-monoxide doublets. Next was a group of neon lines in the red. Some indication of the presence of cyanogen also was found, in the violet.[3] A. W. Wright[4] reported the Swan spectrum in the gases derived from meteorites. I have not been able to detect the Swan bands in the spectrum of the gases from this or any other meteorite thus far examined. Wright says that the Swan bands were narrower in the meteorite-gas spectra than in cometary spectra. They differed somewhat also in position from the comet bands, the difference increasing toward the blue end of the spectrum. The carbon-monoxide spectrum differs from the Swan spectrum in exactly this way, and since it is the dominant feature of all the spectra of meteorite-gases that I have seen, I believe that it is probable that what Wright called the Swan spectrum was due really to carbon monoxide. The true Swan spectrum is due to the C_2 molecule.

My thanks are due to the Plastics Industries Technical Institute, 186 South Alvarado Street, Los Angeles, California, for the use of their laboratory facilities.

References

[1] F. C. Leonard, *C.S.R.M.*, **2**, No. 4, 270; *P. A.*, **49**, 214-15, 1941.
[2] J. D. Buddhue, *Am. Jour. Sci.*, **239**, 839-44, 1941.
[3] J. D. Buddhue, *ibid.*, **238**, 569-72, 1940.
[4] A. W. Wright, *ibid.*, **12**, 165-76, 1870.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Light Curves of Twenty-Five Long Period Variables: Over the course of thirty years, about 400 variable stars of long period have been under observation by the A.A.V.S.O. During the past twenty years, the ledgers of ten-day means of the individual observations of each variable have been maintained at headquarters, and these ten-day mean values have proved useful in many ways; not only in the derivation of the smoothed curves, but in the studies of varying heights of maxima and determination of period, and also in supplying ready material for the derivation of mean light curves and the classification of the variables themselves.

In the year 1920, a tentative classification of long-period variables was made, using the then less abundant material at hand, and this was still further modified and improved about ten years later. A classification according to shape of mean light curve was adopted, dependent on the ratio of width of maximum to minimum and also on the ratio of the rate of ascent to that of descent. "A" type indicated those variables having a wider maximum than minimum, "B" those with maximum and minimum of equal width, and "C" those with narrower maximum than minimum. Type "D" denoted a definite secondary maximum and minimum, such as we find for R Centauri and R Normae. The sub-division "a" indicated a rate of ascent equal to that of descent, "b" the ascent steeper than the descent, and "c" the descent steeper than the ascent, "d" noted a point of inflection, or still-stand, generally on the ascent to maximum.

Although it has long been recognized that several types of curves exist amongst the variables, we find that the lines of demarkation from one type to another are frequently not too distinct, and there appears to be a good continuity from type to type.

With considerable more of the observational data at hand than was the case a decade ago, it seems desirable to derive anew the mean light curves for as many of the long-period variables as possible. The earlier derived curves gave us suggestion as to type, but newer determinations will doubtless provide us with more reliable curves, those which are truer to the average form of variation followed by the star in question.

This note presents some of the results of a discussion of 25 long-period variables contained between $00^h\,00^m$ and $1^h\,12^m$ of right ascension; most of the types are included, with periods ranging from 142 days to 445 days, and with ranges from $2^M.9$ to $7^M.6$. The total number of estimates included is 31,050, an average of 1,242 observations per variable, between extremes of 188, for U Sculptoris, and 5510, for R Andromedae. The average number of ten-day mean values used in each curve is 336—ranging from 99 to 680. The greatest possible number of such values would be 690, if observations had been made during each ten-day interval over the years covered by these observations.

As an aid in the determination of type, two numerical parameters have been used, one, the ratio of A/D—ascent to descent, the other M/m—the maximum

to the minimum. When A/D is less than unity, the rise is steeper than the fall; when equal to unity, they are equal; and when greater, the fall is steeper than the rise. In the case of M/m, unity denotes equality; less than unity, maximum narrower than minimum; and greater, maximum broader than minimum.

The accompanying table gives the deduced data for the 25 variables here discussed. Columns 1 and 2 give the designation and name of the variable, column 3 the number of observations made on that variable, and column 4 the number of ten-day mean points used in the determination of the mean light curve. Columns 5 and 6 give the values of the two parameters A/D and M/m, respectively.

		No.	No. 10[a]			—Av. Dev.—				
Design.	*Name*	*Obs.*	*Means*	*A/D*	*M/m*	*Per.* [a]	*Max.* [a]	*Min.* [a]	*Range* [M]	*Type*
000339	V Scl	265	194	0.96	0.59	296	7.0	8.9	4.6	Ca
000451	SS Cas	671	161	0.92	0.65	142	4.4	3.7	2.9	Ca
001032	S Scl	1398	448	0.90	0.95	366	6.4	13.2	6.3	Bd
001046	X And	1545	455	0.59	0.60	346	9.0	10.1	5.3	Ca
001726	T And	1500	399	0.97	0.76	281	5.1	7.2	5.3	Ca
001755	T Cas	5510	680	1.35	1.56	445	7.4	9.9	4.2	Ad
001838	R And	4325	499	0.58	0.84	409	12.2	17.4	7.6	Cb
001862	S Tuc	829	359	0.80	0.90	240	9.5	7.5	5.2	Bb
001900	S Cet	1288	335	0.98	0.97	321	7.8	9.9	6.1	Bd
002438a	T Scl	122	99	0.94	1.24	203	5.0	4.8	4.2	Aa
002546	T Phe	531	273	0.60	0.52	281	6.3	4.9	4.9	Cb
003179	Y Cep	1224	389	0.60	0.60	333	4.0	6.1	5.6	Cb
004047a	U Cas	1355	380	0.87	0.85	278	6.6	8.9	6.6	Cb
004132	RW And	982	307	0.53	0.57	431	8.5	8.9	6.9	Cb
004435	V And	694	308	0.97	1.00	258	6.0	4.5	5.1	Ba
004435	X Scl	224	191	0.87	0.79	259	5.6	7.3	3.6	Cb
004533	RR And	565	285	1.00	0.86	329	5.1	5.4	6.5	Ba
004746a	RV Cas	1113	383	0.65	0.66	331	6.6	9.4	6.1	Cb
004958	W Cas	2888	572	0.94	1.31	406	6.9	6.1	3.0	Aa
005475	U Tuc	1264	478	0.94	0.66	262	4.7	7.0	5.3	Ca
010102	Z Cet	1291	403	0.96	0.82	184	7.1	6.4	4.3	Ca
010630	U Scl	188	160	0.63	0.57	334	6.4	5.2	5.3	Cb
010940	U And	618	307	0.74	0.52	347	8.0	6.7	4.3	Cb
011041	UZ And	444	245	0.63	0.47	314	6.6	10.1	4.8	Cb
011208	S Psc	217	160	0.64	0.33	406	8.7	8.5	5.3	Cb
	Means	1242	336	0.80	0.78	312	6.8	7.9	5.2	Cb

Column 7 gives the mean period, with the average deviation of the individual dates of maximum and minimum from the mean value given in columns 8 and 9. Column 10 gives the mean range of variation of the star.

It must be recalled that the values of range are means only, and, as is well known, the actual range may change considerably. We find many cases in which a variable, especially at maximum phase, may vary over several magnitudes from one maximum to the next and, to a limited extent, we believe the minima also vary in depth. The last column gives the letter classification for the type for each variable. Average values for some of the columns are given in the last line of the table. The average number of observations per point is 3.8.

The mean light curve for these 25 long-period variables, constructed from the ten-day means for each ten-day phase before and after maximum, are illustrated in the figure, classified under types A, B, and C. Smoothed curves have not been drawn through the points, since it is felt that a better idea of the accuracy may be obtained by plotting the individual means. It is readily seen that type C predominates: 17, or 68 percent, being of this type. Of those of type C, five

have ascent equal to descent, and 12 have more rapid rise than fall. There are three variables of type A, two with equal rise and fall, and one, T Cassiopeiae, subject to a decided still-stand at or near maximum phase. Type B includes five variables, three with equal rise and fall, one with rise slightly more rapid than the fall, and one, S Sculptoris, with a slight still-stand on the increasing portion of the light curve. When these points of inflection show up on a mean light curve, they give very good proof of their reality, especially when they occur near one particular phase, otherwise they would be cancelled out in the means. Because

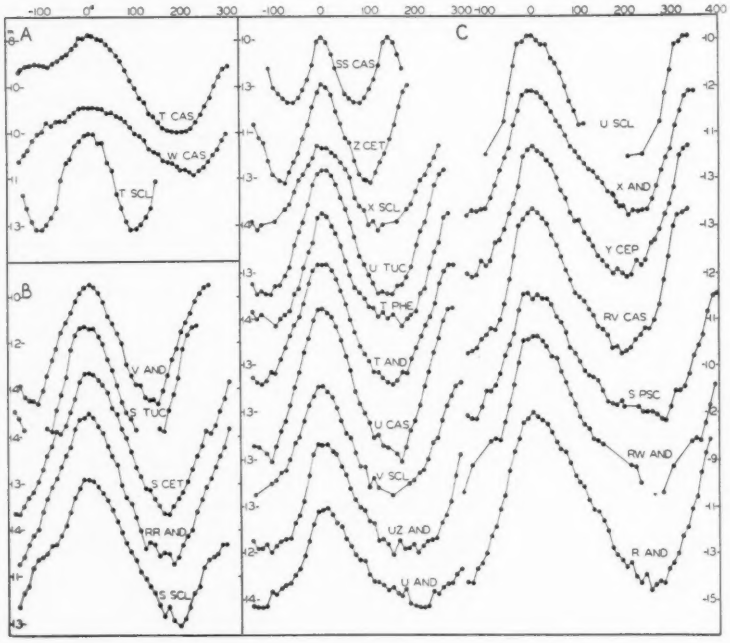

FIGURE 1
MEAN LIGHT CURVES OF LONG-PERIOD VARIABLES

of the fact that observations are more numerous and more readily made at maximum than at minimum, much more reliance can be placed upon the form of the curve at maximum phase. When minimum light goes below magnitude 14, some uncertainty must exist, except when the observations have been made with a large telescope. For some of the very faint variables, the McCormick 26-inch telescope was used with considerable success for a number of years, and accordingly, much dependence can be placed upon the values at minimum phase for the stars thus observed.

Future Variable Star Notes will doubtless contain further discussion of other long-period variables.

Observers and Observations received during December, 1941:

Observer	Var.	Est.	Observer	Var.	Est.
Albrecht	19	26	Koons	32	40
Ball, A. R.	27	43	Leavitt	8	8
Bappu	38	97	Lovinus	14	14
Blunck	18	20	Manlin	48	51
Bouton	57	80	Mason	36	57
Cave	2	2	Maupomé	127	130
Cilley	47	98	Nadeau	38	50
Cousins	36	52	Palo	6	6
Fernald	129	261	Parker	14	14
Ford	30	32	Parks	28	57
Giese	16	21	Peltier	138	188
Griffin	12	12	Reeves	1	2
Halbach	90	131	Rosebrugh	12	26
Harris	14	14	Schoenke	30	43
Hartmann	135	186	Sill	42	42
Hayner	6	6	Smith, F. P.	13	13
Holt	77	122	Taulman	16	20
Houghton	24	24	Topham	18	18
Howarth	18	21	Toyek	2	2
Jones	44	119	Vohman	3	3
Kearons	93	206	Webb	31	38
Kelly	7	13	Weber	33	33
Kerns	6	8	—		—
deKock	63	235	46	Totals	2484

January 15, 1942.

Comet Notes

By G. VAN BIESBROECK

As the year opens two faint comets continue to be under observation. They are COMET 1941 *d* (VAN GENT) and PERIODIC COMET 1941 *f* (SCHWASSMANN-WACHMANN No. 2). The first one has been followed continuously since it was discovered on May 27, 1941, in the southern hemisphere. Its orbit seems to be very nearly a parabola. Last night I found the comet still very close to the ephemeris position given by J. Bobone of Cordoba (Argentina). It appeared as a round fuzzy coma with a diffuse central condensation. The magnitude was about 12 which is a little brighter than was predicted, but from now on the comet will fade rapidly as can be seen from the following continuation of Bobone's ephemeris.

1942	α h m	δ ° ′	Mag.
Feb. 2	3 36.5	+3 10	15.1
10	38.0	2 30	15.5
18	40.9	2 4	16.0
26	3 44.7	+1 46	16.4

Although the comet is well situated in Taurus the period of visibility will soon come to an end.

Equally well situated for northern observers is PERIODIC COMET SCHWASSMANN-WACHMANN 2 which comes to perihelion on February 14. It is now brighter than van Gent's comet. Last night I recorded it as an 11^{M} object consisting of a well-defined nucleus preceded by a broad fan-shaped coma making a coarse tail extending over 2′ of arc. I have computed the continuation of the ephemeris from the elements by W. P. Henderson and H. Whichello in the 1941

Handbook of the British Astronomical Association.

1942	α (1942.0) h m	δ (1942.0) ° ′	Distance from Sun	Distance from Earth	Mag.
Feb. 2	7 20.8	+21 23	2.15	1.21	11.1
10	17.8	21 50	2.15	1.25	11.1
18	16.8	22 12	2.14	1.30	11.2
26	17.9	22 29	2.15	1.36	11.3
Mar. 6	21.2	22 39	2.15	1.43	11.4
14	26.4	22 44	2.15	1.50	11.5
22	33.5	22 41	2.16	1.59	11.7
30	42.3	22 33	2.17	1.68	11.8
Apr. 7	7 52.3	+22 18	2.18	1.77	12.0

The ephemeris requires a correction of $+1^m5$ in right ascension, none in declination. The comet will move slowly across the constellation of Gemini and it is seen that not much change in brightness is anticipated. No other comets are expected in the immediate future.

Professor S. G. Barton of the department of astronomy of the University of Pennsylvania in Philadelphia has undertaken to determine a definitive orbit for Comet 1912 III (Borrelly).

Williams Bay, Wisconsin, January 10, 1942.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Comments on Two Papers in the April Issue

Two contributions in Popular Astronomy for April (1941) interest me. The first of these is the article by Arthur T. Adams on the cause of tides. He attributes tides solely to centrifugal force. He virtually repeals the law of gravitation. He would abolish the idea that gravitation varies inversely as the square of the distance between the attracting objects or particles. In support of this he quotes Young where that author states: "Spheres attract and are attracted precisely as if they were wholly collected at their centers." This is true so far as it applies to the sphere as a whole, but the absurdity of urging it as a reason for ignoring differential gravitation is that it is in reality derived by a mathematical demonstration based on the very law that Mr. Adams would repeal or ignore. It would not be true of a figure of any other shape than a perfect sphere (solid or hollow). Young is careful to confine the statement to *spheres*. It is not strictly true of the earth, which is a spheroid.

Incidentally, as I have shown in Popular Astronomy for April, 1938, the whole behavior of comets is made clear by applying the law of gravitation to every particle and not confining its effect to the comet as a whole. It will take astronomers a long while to see this.

If Mr. Adams would analyze his forces as we engineers analyze forces in the design of a structure, he would discover that, even assuming that there is no difference in the gravitation of the moon for the near particles and the far particles of the earth, applying the law of centrifugal force to all particles due to

the earth's revolution around the center of gravity of earth and moon, there would be absolutely no elliptical elongation of the earth, were it as flexible as a rubber ball. The earth would be flattened at the poles (when the moon is on the equator), but all circles parallel with the equator would remain perfect circles.

In a contribution in POPULAR ASTRONOMY, August-September, 1934, I proved this by an analysis which I challenge anyone to controvert.

It is differential gravitation solely that elongates the *earth* in the direction of the radius vector of the moon, and I mean the *earth,* the solid *earth.* The water is not raised a hair's breadth by this differential gravitation; the earth itself is heaved.

High tide is then around on the side, where the body of the earth itself is drawn in, where it is always observed to be, and never under the moon.

The tide never rises in a port on an eastern shore of the open ocean, such as New York, until after the moon has set. The bay in New York is not so long or tortuous that it takes the tide wave, that has crossed the ocean at 1,000 miles an hour, *eight hours* to creep up to the Battery from the outer limits of the harbor.

It is the rise and fall of the great body of the earth, produced by the gigantic force of differential gravitation, that causes the tide, and this is a fact that all of the authorities from Newton down have utterly missed. G. H. Darwin brings in centrifugal force in his explanation of tides, but he makes the egregious blunder of saying that centrifugal force of all particles of the earth due to its revolution about the center of gravity of earth and moon is equal and directly away from the moon. Nothing could be more erroneous. Centrifugal force must be directly away from the center or axis of revolution. And centrifugal force has a real influence utterly ignored by astronomers. An eminent living astronomer told me in a letter that " We astronomers do not consider centrifugal force as real but fictitious." I told him that we engineers design flywheels and bridge bracing (for bridges on curves) for centrifugal force as a real and fearfully destructive force.

It is the heaving of the body of the earth that fully explains the minute shifts in star locations which a hundred thousand observations made on these shifts prove to agree precisely with the position of the moon.

The other item in your April issue is that by Mr. W. E. Speas concerning a luminous streak seen in the western sky, of which he says that the "new moon was almost in the center of the apex toward the top." He also says that a luminous patch was observed in the east. He attributes these to ionization. There might be some excuse for ionization in the west, where the sun was working, but why in the east, where the dark side of the earth is located at sunset?

I think my contribution to POPULAR ASTRONOMY, October, 1939, page 454, would fully explain this phenomenon. Layers of the earth's atmosphere moving swifty on one another, *forced to it by the moon,* which was right in line with the particular streak of electricity at the time, charged the air with static electricity, as in all examples of Zodiacal Light.

There is no ionization when the wind blows past a cloud and charges it with electricity. This can happen in pitch darkness.

EDWARD GODFREY.

Professional Building, Pittsburgh, Pa.

Origin of the Planets by Electrostatic Ejection

SOURCE OF THE SUN'S ENERGY

We are familiar with matter in three different physical conditions: solid, liquid, and gaseous. Let us suppose that there is a fourth physical condition, which we shall call *pycnum* (*Greek "pycnos:" dense*). This condition is assumed

by matter at temperatures above that which prevails in the sun's deep interior—let us say 40,000,000 degrees. At this temperature gases may be transformed into pycnum with the absorption of heat. This process may be called *pycnosis,* and is analogous to "fusing" and "boiling." At the same temperature pycnum is transformed into gases with the evolution of heat. This process may be called *aerofaction,* and is analogous to "condensation" and "solidification."

At this critical temperature, which we assume to be 40,000,000 degrees, the atoms of elementary gases are entirely stripped of their electrons. In the pycnous condition, therefore, intra-atomic spaces are abolished, so that pycnum is an exceedingly dense material. Pycnum is the substance of which the nucleus of the sun and of the stars in general is composed. It is also the substance of which white dwarfs, and the central stars of planetary nebulae are composed. In the process of aerofaction pycnum is converted into completely ionized elementary gases, with the evolution of latent heat. Due to secular cooling, aerofaction is now taking place in the sun's deep interior. The sun's pycnous nucleus is disintegrating into gases. The source of the sun's radiant energy is *the latent heat of aerofaction.*

Under this view new-born stars consist entirely of pycnum at enormously high temperatures—of the order, perhaps, of a billion degrees. The new-born stars immediately begin to cool by radiation. In the course of perhaps billions of years, the temperature gradually falls until the critical temperature of 40,000,000 degrees is eventually reached at their surfaces. At this point aerofaction begins. Pycnum at the surface of the star disintegrates into elementary ionized gases with a tremendous evolution of latent heat. The star becomes surrounded by an envelope of gases, which are the product of aerofaction. The original pycnous mass becomes the nucleus of the star. Aerofaction continues until all of the pycnous material of which the star was originally composed has been converted into gases. The complete aerofaction of a star probably requires billions of years. Cooling of the pycnous nucleus is blanketed and retarded by an accumulating envelope of gases. An aerofaction progresses, the pycnous nucleus shrinks, and the envelope of gases thickens. The temperature at the surface of the star's nucleus, of course, remains at 40,000,000 degrees until the nucleus entirely disappears.

During the process of aerofaction, the density of a star must *decrease,* because the density of gases is inconsiderable compared to that of pycnum. The process of aerofaction thus corresponds to the *giant* series. After the pycnous material of the star has been entirely converted into gases, further cooling will result in contraction of the mass, and, eventually, in condensation and solidification. During this process the density of the star must *increase.* This process, therefore, corresponds to the *main sequence.* The evolution of a star consists basically in secular cooling. But the matter is not so simple as this. Stellar evolution is complicated by factors which, at the present time, are unknown and unsuspected.

The process of aerofaction is probably accompanied, not only by the evolution of latent heat, but by the generation of *positive electricity.* This positive electricity collects as a gradually increasing charge upon the nucleus of the star. If aerofaction is accompanied by the generation of positive electricity, it is probable that generation of positive electricity also occurs in connection with analgous processes of condensation and solidification. This, of course, could be tested by laboratory experiment. But it should be borne in mind that the quantity of electricity produced under laboratory conditions would probably be so minute that it would escape detection unless extremely delicate methods were employed.

A *nova* is formed when the gaseous envelope of a star is suddenly repelled from the star's pycnous nucleus by electrostatic forces. The star is *exploded by electricity*. This event occurs when the positive charge on the nucleus eventually becomes of sufficient magnitude to overcome gravitation. It can occur only in stars which are *deficient in electrons*. In such stars the gases produced by aerofaction remain highly or completely ionized, and are therefore positively charged. They are repelled by the positively charged nucleus. It follows from this explanation that a nova should be of greater brilliance *before* its outburst than *after* the outburst has subsided. This is in accordance with observed facts.

If novae are the first stage in the repulsion of the gaseous envelope of a star, then planetary nebulae are the second stage in the same process. Indeed, Nova Persei was observed to develop into a planetary. The "faint central star" characteristic of planetary nebulae is the pycnous nucleus of the star, which stands exposed to view by the recession of the star's gaseous envelope.

The gaseous shells of planetary nebulae are expanding. A later stage of the process is represented by the symmetrically disposed Veil Nebulae in Cygnus, which are obviously arcs of the same circle. If this view is correct, it follows that there should be a white dwarf star located near the center of the parenthesis formed by these two nebulae. The diffuse nebulae are the final stage. These nebulae consist in accumulations of gases that have been repelled to immense distances—swept, as it were, into the corners of space. Under this explanation the gases of diffused nebulae should be highly ionized—as, indeed, they are.

White dwarfs are the *pycnous nuclei* of stars which have lost their gaseous envelopes in the above described process. In the case of these stars aerofaction is still proceeding, but the newly formed gases are being driven away by electrostatic repulsion as fast as they are formed. A white dwarf star consists in a mass of pycnum, surrounded by a thin film of newly formed gases. The temperature of white dwarfs must be equal to or higher than that of Class O stars.

Origin of the Planets

Under this theory the production of planets is a typical feature of stellar evolution, and systems similar to ours are probably common throughout the galaxy. The planets of the solar system originated as rising vortices in the gaseous envelope of the sun. These vortical gaseous masses were driven out of the sun to considerable distances by electrostatic repulsion. Solar vortices which produce planets differ only in *magnitude* from those which produce sun spots. To put the matter briefly, a planet is merely an overgrown sun spot which has been pushed out of the sun.

Masses of newly formed gases, produced by aerofaction, originate at the surface of the sun's nucleus. These gases, being completely ionized, are positively charged. The sun's nucleus also carries a positive charge that was generated by the process of aerofaction. The newly formed gases are driven away from the sun's nucleus by electrostatic repulsion and, pursuing a tortuous course, rise toward the sun's surface. In rising through the sun's gaseous envelope, which is probably nearly 400,000 miles thick at the present time, the gaseous masses undergo the following effects:

1. In passing from regions of high pressure to regions of low pressure, they expand and cool. Thus, in rising from the sun's deep interior to the surface, their temperature falls from many millions of degrees to about 5,000, which is the observed temperature of sunspots.

2. In rising through the sun's gaseous envelope, they acquire a vortical

motion, on the same mechanical principles as terrestrial cyclones. Thus the rotation of the planets is *native,* being acquired before their birth as a vortical motion in the sun's deep interior.

3. As a result of this vortical motion, gyroscopic effects ensue. If the path of the rising gaseous mass lies near the plane of the sun's equator, then the axis of the vortex would lie at right angles to that of the sun. Rotation of the sun would tend to turn the axis of the vortex upon an axis parallel to the axis of the sun. The vortex would respond by turning upon an axis perpendicular to the direction of this line. In other words, the vortex would endeavor to assume a position in which its axis was parallel to the axis of the sun. Just how far the vortex would progress toward reaching this position would depend upon several factors, including the thickness of the sun's gaseous envelope, and the speed of the sun's rotation. Thus the inclination of the axes of the planets to their orbital planes is acquired before their birth, as a gyroscopic effect in the sun's interior.

4. As the gaseous masses rise through the sun's gaseous envelope, their electrical charges are reduced by the acquisition of free electrons.

In the case of relatively small gaseous masses, such as produce sunspots, the electrical charge is nearly or entirely neutralized by the time they reach the surface of the sun, so that they rise no farther, but spread out over the photosphere. In the case of a relatively large mass, such as may produce a planet, most of the electrical charge is retained, so that the mass of gas, upon emerging from the photosphere, continues to recede from the sun, being driven by electrostatic repulsion, and may eventually reach a considerable distance—perhaps many hundreds of millions of miles.

The gaseous mass, after ejection from the sun, continues, as it recedes, to pick up electrons discharged from the sun, so that its positive charge becomes gradually reduced. Its radial recession is eventually halted when an exact balance is attained between electrostatic repulsion and gravitational attraction. The gaseous mass has a tangential velocity which was conferred upon it by the sun's rotation, and which, of course, is in the same direction as the sun's rotation. As the mass recedes its tangential velocity remains constant, while the rotational velocity of the sun decreases. Recession of the mass is equivalent to expansion of the sun. Thus angular momentum is transferred from the sun to the planet by electrostatic forces. The planet, as it recedes, robs the sun of angular momentum.

At this stage the gaseous mass has become a young planet. Due to rapid cooling, a liquid nucleus has formed at its center. Due to contradiction of the mass by cooling, the rotational velocity has increased, so that it is now spinning rapidly. The gaseous envelope has assumed a lenticular shape, and has perhaps thrown out an equatorial fringe of gases, in which rings or satellites may form by condensation. At this stage the young planet presents a perfect replica in miniature of a spiral nebula. It may well be suspected that this striking resemblance is by no means a coincidence, but reflects a similarity of origin. In other words, it is probable that spiral nebulae also are born by electrostatic ejection.

As the planet's electrical charge becomes further reduced, by continued acquisition of electrons, gravitational attraction prevails over electrostatic repulsion, and the planet spirals in toward the sun, its orbital velocity increasing as its distance from the sun diminishes. Its approach toward the sun ceases when its electrical charge is entirely neutralized. Its orbit then becomes a true planetary orbit, in which gravitational attraction is exactly balanced by centrifugal acceleration. It is evident that the more rapidly a planet's charge is lost, the more eccen-

tric will be its orbit. It is also evident that the smaller the planet, the quicker its charge will be lost. Thus the two smallest planets, Mercury and Pluto, have the most eccentric orbits.

After the planet's approach toward the sun is halted, it begins to recede once more, due to two causes: first, friction of solar tides in the still liquid body of the planet; second, loss of mass by the sun by radiation.

The vast majority of gaseous masses formed at the surface of the sun's nucleus develop into sunspots, being too small to get out of the sun. Others, although actually ejected, are too small to hold together, and disperse into space, forming the source, perhaps, of the zodiacal light and gegenschein. Still others, upon loss of their electrical charge, fall back into the sun. Requisite conditions as to size, radial and tangential velocities are so exacting that only an infinitesimal percentage of these masses develop into planets. Mercury is probably the last of the sun's progeny. Aerofaction in the sun has become so far advanced that gaseous masses of planetary dimensions are no longer formed. And besides, the sun has not sufficient angular momentum left to launch another planet.

It is not until a star has reached the Class F stage of evolution that the growing electrical charge upon its nucleus becomes sufficient to repel newly formed gases against gravity. It is in the Class F stage, therefore, that the production of planets by a star begins. A star cannot produce a planetary system unless it has a high rotational velocity, like Spica or Altair. Thus Class A and Class B stars, which are rotating rapidly, have not yet produced planets. It is an observed fact that Class F stars rotate more leisurely. This is because Class F stars have begun to produce planets. Stars of Classes G, K, and M have produced planetary systems, and therefore rotate scarcely at all.

Agreement of this Theory with Observed Facts

The theory of *electrostatic ejection* provides the only way in which angular momentum could possibly have been transferred from the sun to the planets. It could have been done only by the operation of electrostatic forces.

Careful consideration of the matter will show that the theory of *electrostatic ejection* affords an obvious explanation of the following observed features of the solar system:

1. The more remote planets are larger and older.
2. The planets all rotate on their axes.
3. Their axes are more or less inclined to their orbital planes.
4. Among the four major planets, the inclination of the equator to the orbital plane decreases with decreasing distance from the sun.
5. The larger and more remote planets rotate faster.
6. The planets all revolve around the sun in the same direction in which the sun rotates.
7. The orbits of the planets are nearly circular.
8. The orbits of the smallest planets are most eccentric.
9. The orbital planes of the planets all lie near the plane of the sun's equator.
10. With a few exceptions, the satellites revolve around their primaries in the same direction in which the latter rotate, and their orbits are nearly circular and nearly in the planes of the planets' equators.
11. The earth-moon system.
12. The asteroids.

Ross Winthrop Gilbert
Box 88, Fruitvale Station, Oakland, California.

Notes from Amateurs

Cleveland Astronomical Society

The mid-winter meeting scheduled for January 16 convened at the Burrell Observatory of Baldwin-Wallace College, Berea, Ohio. There we enjoyed a lecture by Dr. O. L. Dustheimer, the Director. His subject was "Telescopes—Past, Present, and Future." Assisting him with many new slides was Professor Paul Annear. Dr. Dustheimer, through the pictures on the screen, introduced us to the many great men of astronomy who have been responsible for the recent advances in this science. Included were views of all the important telescopes which they used. After the meeting we viewed Saturn and its moons through the telescope in the dome. The weather was cold and we looked like Eskimos scurrying around and waiting our turn at the eyepiece.

The Burrell Memorial Observatory at Baldwin-Wallace College conducts a program every Wednesday evening at 8:30 P.M., and if you wish to avail yourself of these facilities call Berea 601 if possible so you can be included in the party. Dr. Dustheimer lectures on the second and fourth Wednesdays and Professor Annear on the first and third.

A discussion of the future plans of the Society was held after the lecture. Dr. S. W. McCuskey of the Warner and Swasey Observatory will speak on the subject "Problems in Stellar Traffic" at the next meeting, which will be held on February 13. He is one of our most popular speakers and always attracts a large audience.

DON H. JOHNSTON.

Euclid Beach Park, Cleveland, Ohio.

Terms Used in Astronomy

Promped, in all probability, by the popularity of the various forms of question and answer now used in entertaining audiences, the following list of phrases having astronomical terms as correlatives has been sent to us for publication, if desired. The sender suggests that by withholding the answers an interesting game would result for persons who have read even to a slight extent in the field of astronomy. They are printed here with the hope that in some instances they may stimulate further astronomical study. EDITOR.

1. A character in one of Poe's tales.....Jupiter
2. Goddess of love and beauty.....Venus
3. God of love.....Eros
4. Seriousness.....Gravity
5. One who puts an end to something.....Terminator
6. Delay.....Retardation
7. A lithographic picture printed in colors, plus a globe.....Chromosphere
8. God of the sea.....Neptune
9. Disfigures.....Mars
10. A metallic element.....Mercury
11. Took a seat, plus a vase.....Saturn
12. Father of the Titans.....Uranus
13. Of or pertaining to a church council, plus a division of the year.....Synodic month
14. Abnormal, plus a unit of time.....Anomalistic year
15. A cloudy supposition.....Nebular hypothesis
16. King of the fairies in one of Shakespeare's plays.....Oberon
17. Sedition.....Revolution
18. Correct rising.....Right ascension
19. Prominent actors.....Stars

20. Starlike ..... Asteroids
21. A lengthening..... Elongation
22. A tool for chopping wood, plus a form of the verb "to be."..... Axis
23. Length. . . . . Longitude
24. Two letters of the alphabet..... Io
25. Great agitations of mind..... Perturbations
26. A character in "The Tempest."..... Ariel
27. Resistance. ..... Opposition
28. A conjunction, plus a personal pronoun, plus a preposition..... Orion
29. A small roller on a swivel fastened under a piece of furniture..... Castor
30. A part of speech..... Conjunction
31. Novel, plus a unit of weight, plus an established rule..... Newton's Law
32. A lacteal road..... Milky Way
33. A refusal. . . .. Declination
34. Breadth, or width..... Latitude
35. A dreaded disease..... Cancer
36. Soft ground. . . .. Earth
37. A unit of time, plus a ring..... Hour circle
38. Greek god of the lower world..... Pluto
39. Objective case of a personal pronoun, plus disencumber, plus nominative case of the same pronoun, plus an article. ..... Meridian
40. A method of action, plus the Latin word for "and."..... Planet

ADA WEBER.

3635 Middleton Ave., Cincinnati, Ohio.

General Notes

Dr. Heber D. Curtis, chairman of the department of astronomy and director of the Observatories of the University of Michigan, died at his home in Ann Arbor on Thursday, January 8, 1942.

The Rittenhouse Astronomical Society held its monthly meeting on January 9 at the Franklin Institute. Dr. George Rosengarten, the retiring president, gave a paper on "Galileo, Scientist and Man," in commemoration of the 300th anniversary of Galileo's death.

Dr. Charles P. Olivier was inducted into office as the new president.

The New South Wales Branch of the British Astronomical Association is conducting a regular series of programs during this season. The meetings for the coming months are to be devoted to special topics as follows:

February 25, "Double Star Measurements," by M. Howarth, and a symposium on "Comets."
March 25, "Astronomy and Defense," by M. J. Maloney.
April 29, "Astronomical Lenses," by K. Beams, and "The Source of Solar Energy," by J. B. Scott.
May 27, "Chinese Astronomy" by E. E. Adderly, and a symposium on "Constellations."
June 24, Presidential Address by H. W. Wood.

A Celestial Bomb

These are days when we are forced to think a good deal about bombs. So the other day when we received as an exchange a group of nicely encrusted aerolites from the Forest City, Iowa, fall of 1890, I began consulting physicists, mathematicians, and ballistics experts, so as to ascertain the bomb-equivalent of the famous meteorite which landed in Iowa on that afternoon 52 years ago.

At least 300 lbs. were recovered from this fall. Taking into account the time of day and the direction from which it came, we may safely assume an extra-atmospheric velocity of 10 miles per second for this invader from space. Had the meteorite reached the soil at this speed it would have exploded with about the same violence as 6000 lbs. of nitroglycerine, or about 6 times the destructiveness of the greatest bomb so far used in this war.

Of course, this only begins to tell the story; for the 300 lbs. recovered were only an insignificant fraction of the original stone which collided with the atmosphere. It doubtless weighed many tons so that except for the protection of the air blanket its landing would have constituted a real catastrophe.

These stones were gathered soon after the fall and they are excellent examples of freshly fallen stony meteorites of the *brecciated spherical bronzite-chondrite* variety. They vary in weight from 118 grams to 346 grams; they may be purchased from the undersigned at eight cents per gram.

H. H. NININGER.
The American Meteorite Laboratory, 635 Fillmore St., Denver, Colorado.

Army Air Corps Training Course

With the increasing number of airplanes being put into active service, the need for more and more men to operate them is urgent. This particular duty calls for specially qualified and highly trained personnel. A letter from the office of the Permanent Secretary of the American Association for the Advancement of Science calls upon colleges and universities to assist in preparing young men for the Army Air Corps Training Course by giving basic instruction for this course. It states "The courses to be given are in the fields of elementary mathematics and astronomy, so far as the latter pertains to air navigation." A committee is now preparing an outline, with suggested materials, for the guidance of institutions which may be able to cooperate in this work.

Junior Astronomers Needed

The United States Civil Service Commission has just announced an examination for Junior Astronomer positions paying $2,000 a year. Positions are immediately available in the Naval Observatory, Washington, D. C. It is possible that appointments will be made to other observatories in the field. In addition, subprofessional positions at $1,800 and $1,620 a year will also be filled from the employment lists set up as a result of this examination.

Junior Astronomers assist in making astronomical observations and computations, caring for the instruments and equipment. Assisting in preparing publications may also be a part of their work.

Because of emergency conditions *the usual written test will not be given.* Applicants will be rated on their education and experience. They must have completed a 4-year college course including or supplemented by 12 semester hours' work in mathematics and 12 semester hours in astronomy. No experience is required, although appropriate credit will be given for it.

Applicants must not have passed their fortieth birthday for any of these positions. Although applications may be filed until further notice, qualified persons are urged to apply at once. Copies of the announcement and application forms may be obtained at any first- or second-class post office or from the Civil Service Commission in Washington, D. C. Applications must be filed with the Commission's Washington office.

Summary of Sun-Spot Observations at Mount Holyoke College, 1941

Month	No. of Obs.	North of Equator No. of Groups	North of Equator Av. Lat.	South of Equator No. of Groups	South of Equator Av. Lat.	Av. No. Groups at one Obs.	New Groups
January	17	8	+10.8	11	—7.0	3.5	19
February	22	10	11.2	13	8.0	3.9	17
March	12	12	13.1	4	9.1	4.6	11
April	21	8	12.2	9	5.8	2.2	17
May	24	5	12.3	6	9.4	2.1	8
June	17	10	10.3	7	8.5	4.0	15
September	12	7	9.7	5	8.1	4.5	12
October	20	9	9.7	3	6.5	3.0	10
November	22	6	8.8	3	9.0	2.4	9
December	12	4	10.0	6	8.1	2.5	7
Totals	179	79		67			125

Average number of groups at one observation 3.14
Average latitude of spots north of equator +11°.1
Average latitude of spots south of equator — 7.5

These figures show the expected trend toward minimum of the sun-spot cycle, in diminution in average solar latitude and in average number of groups seen at one observation. The spread in latitude is large, nine groups being recorded within 2° of the equator, and twelve at latitudes higher than ±15°.

On six days of observation (April 3, May 29, November 8 to 11) no spots were seen. On no occasion since October 9, 1935, has this been true, the longest such interval in our records.

The observations were made largely by Miss Jocelyn Gill.

ALICE H. FARNSWORTH

John Payson Williston Observatory, South Hadley, Massachusetts.
January 12, 1942.

The Astronomer's Version of "Hey Diddle Diddle"*

Hey diddle diddle, the Sun's in the middle,
And 'round him the planets so grand
Are swinging in space
Held forever in place
By the zodiac's circle or band.

Hey diddle diddle, the Sun's in the middle,
And Mercury's next to the Sun,
While Venus so bright,
Seen at morning or night,
Comes second to join in the fun.

Hey diddle diddle, the Sun's in the middle,
And third in the group is our Earth,
While Mars with his fire,
So war-like and dire,
Swings 'round to be counted the fourth.

Hey diddle diddle, the Sun's in the middle,
And Jupiter's next after Mars;
His four moons so bright
Tell the speed of the light;
Next, golden-ringed Saturn appears.

Hey diddle diddle, the Sun's in the middle,
After Saturn comes Uranus far,
While more distant still,
In darkness more chill,
Comes Neptune, who drives the last car.

Hey diddle diddle, the Sun's in the middle,
But Neptune's no longer the end,
For 'way out in space,
Though still in the race,
Runs Pluto, whom now we'll append!

*The first five stanzas were found in an old song book at Queen's University, Kingston, Ontario, Canada, in 1908. A sixth stanza is added, to bring the "poem" up to date!—FREDERICK C. LEONARD.

Victory Book Campaign

The Victory Book Campaign is a movement under the sponsorship of the American Red Cross, the United Service Organizations, and the American Library Association. Its purpose is to collect books, voluntarily contributed, and to send them to forts, camps, posts, stations, ships, and U.S.O. recreational centers. This is highly desirable because proper reading is productive of better morale, and this kind of reading material now at the disposal of men in the armed forces is quite inadequate. Fiction, biography, travel, history, and informational books of all types are needed. The project is to continue until the end of April, 1942.

The Campaign is nation-wide, and every public library will be used as a collection center. The public libraries will also furnish additional information regarding the plan.

Book Reviews

Cassini's Planisphere Terrestre of 1696. (William L. Clements Library, University of Michigan, Ann Arbor.)

Realizing that the copy of this classical map in the William L. Clements Library was one of four copies known to exist, the Curator of Maps, Mr. Lloyd A. Brown, felt justified in having collotype facsimiles of this important map made. These were hand-colored after the original. This having been done, Mr. Brown was impressed with the desirability of having an historical account of the map and a description and interpretation of it at hand. Accordingly he prepared a booklet of seventy-seven pages incorporating the information available. This booklet lends much to the meaning of the map which itself is of great intrinsic interest.

The map is a circle about twenty-two inches in diameter, the north pole of the earth being at the center. It extends to sixty degrees south of the equator, which, apparently was as far as knowledge of the earth's surface extended at that time. New Zealand is pictured in about the same latitude as the southern part of South America, which is nearly correct, although both are placed rather too far south. Although the map was originally drawn on the floor of the Paris Observatory, the prime meridian is not drawn through Paris but through Ferro Islands, the western-most of the Canary Island some twenty degrees west of Paris. In this Cassini followed Plotemy (ca. 150 A.D.) who established his prime

meridian here believing it probably to be the western extremity of the habitable world.

Cassini is a name well known in astronomy also. In these early days the sciences were not so distinct as today, hence it is not strange that the same person should be concerned with terrestrial and celestial studies.

The William L. Clements Library deserves credit and will receive the gratitude of all concerned in thus preserving this ancient document for future generations.

C.H.G.

The Observer's Handbook for 1942, published by The Royal Astronomical Society of Canada, Toronto, has recently been issued. It is a pamphlet of eighty pages which are filled with astronomical data of various kinds. It would be difficult to think of a question which might arise in the mind of an amateur observer for which an answer or a clue to an answer could not be found in this pamphlet. This is the thirty-fourth year of publication and during these years this work has made a place for itself. It is eagerly looked for by many.

C.H.G.

Edmond Halley as Physical Geographer, and the Story of his Charts, by S. Chapman, M.A., D.Sc., F.R.S., President of the Royal Astronomical Society. (University Observatory, Oxford, England. 2s 6d.)

This is an octavo pamphlet with six large plates. The plates represent the charts mentioned in the title and are essentially maps of the surface of the earth as it was believed to be about 1700 A.D. It is a surprise to most persons to connect the name Halley with such matters, since it is usually associated with his astronomical work and predictions. However, if his name had never become associated with a long-period, spectacular comet, "he would still have been remembered as one of the fathers of physical geography, through his own observations in meteorology, the Earth's magnetism, and the tides, and for his theoretical studies in these sciences."

These charts and the comments concerning them are of interest in showing the beginnings of what later became exact sciences. We are apt to forget that the vast stores of knowledge now available to us were assembled with painstaking care over long periods of time by various persons. We are greatly indebted to those pioneers whose imagination led them to lay foundations upon which future generations might build useful and enduring structures.

C.H.G.

The Physical State of the Upper Atmosphere, by B. Haurwitz. (Royal Astronomical Society of Canada, Toronto. 75 cents.)

This paper-bound pamphlet of 96 pages consists of material first printed in the *Journal of the Royal Astronomical Society of Canada* in 1936 and in 1937, supplemented by additional material prepared in 1941. It deals with the subject of meteorology and as such is of special importance at this time. In addition to the discussion here given, there is to be found an extended bibliography of the literature in this field, which constitutes a very valuable feature.

C.H.G.

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